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REPORT ON THE PROPOSED 226-MILE AQUEDUCT FOR THE WATER SUPPLY OF LOS ANGELES, CAL.*

We herewith submit the following report upon the project of the city of Los Angeles for obtaining an additional supply of water from the Owens River and its tributaries.

On undertaking this work you gave us the following subjects for investigation and report:

(1) To study the hydrography of the Owens River drainage basin, with special reference to its reliability as a source of water supply, from data to be furnished by you, and such other data as may be obtained from any other reliable source.

(2) To make an examination of the quality of the water at the proposed point of intake, and the possibility of its quality being affected in process of transmission to its destination.

(3) To make an examination of the route over which the proposed aqueduct is to be built, and to review any alternate lines where such may be conducive either to saving in cost, time of construction, or safety of maintenance.

(4) To make an examination of proposed reservoir sites, and to consider their value in regulating variation in flow from the source.

(5) To study the capacity of the several sections of the aqueduct with a view to making suggestions as to any alterations necessary to enable it to properly meet variable conditions of flow.

(6) To study the designs and materials proposed to be used in the construction of the aqueduct, with a view to making any suggestions of necessary amendments or changes.

(7) To estimate the cost of the aqueduct, reservoirs and all accessories complete, from intake to point of exit in the San Fernando Valley.

(8) To estimate the time required to complete the entire project as outlined.

(9) To estimate the amount of water power that may be developed along the line.

(10) To make recommendations for the best executive and engineering organization for the construction of the aqueduct.

(11) To prepare and submit to you, in writing, a report on all matters hereinabove specified, and any other matters pertinent to the project that this Board of Engineers may deem of importance. In addition, we were officially informed that the time required for making the investigations and report would be approximately 30 days.

The board convened in Los Angeles on Nov. 14, and has been continuously engaged upon the work to the present time. In addition to this time devoted to the work by the board as a whole, Mr. Freeman, by request, visited Los Angeles in August for obtaining preliminary data, and Mr. Schuyler made two trips over the aqueduct in October, making suggestions as to material changes in the route, which have met with our unanimous approval.

These preliminary examinations have greatly facilitated the subsequent proceedings of the board.

EXAMINATIONS.

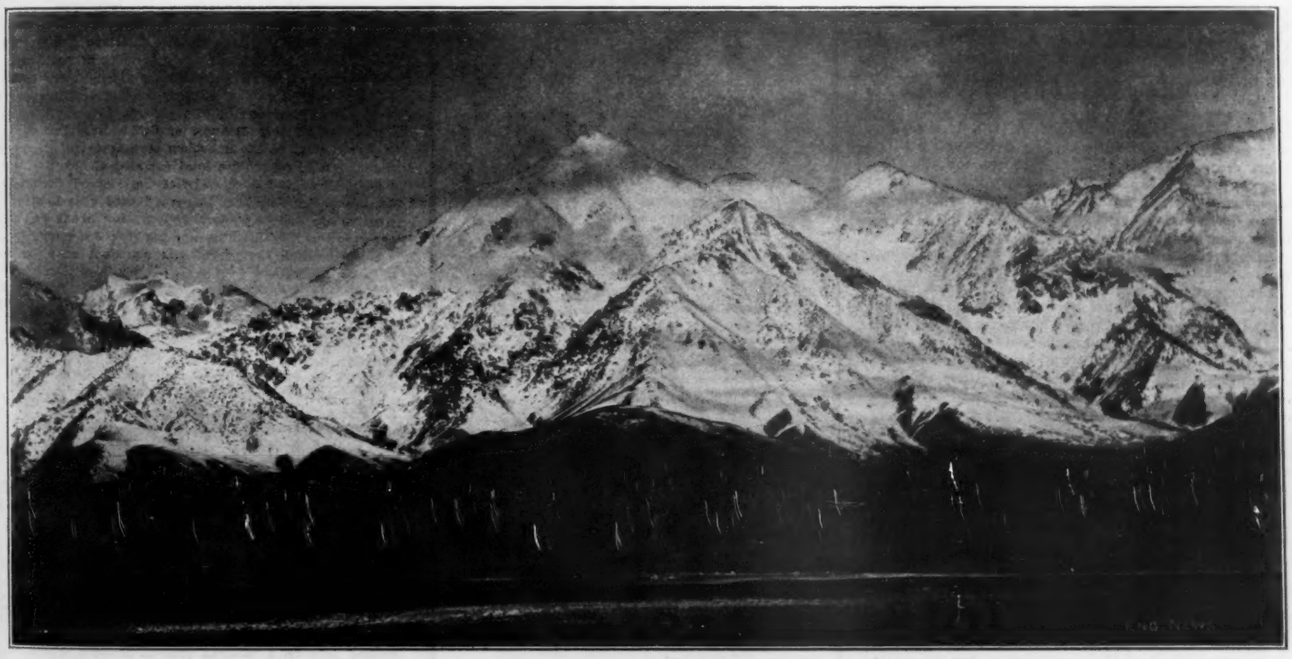
After devoting Nov. 14 to a study of the plans, Nov. 15 was given chiefly to an examination of the Los Angeles River, the San Fernando Valley and the reservoir sites therein.

On the following day a start was made over the territory in question in automobiles from Saugus, accompanied by the chief engineer, William Mulholland, and principal assistant engineer, J. B. Lippincott, on a trip of 11 days duration, which extended to the Long Valley reservoir site in the northerly part of the Owens River Valley. During this examination we inspected the various streams which flow into Owens River, examined and sampled the water of Owens River at three places; investigated the Haiwee Reservoir site and also the line of the aqueduct from the proposed point of diversion on Owens River, all the way to the San Fernando Valley. Eight days were spent in the examination of the aqueduct line, much of the time in walking over the line, especially at the more important points.

CAPACITY OF SOURCES OF SUPPLY.

Measurements of the flow of Owens River and its tributaries were made by the United States Geological Survey for two years beginning in August, 1903, and measurements of the flow of the river have been continued during the past year by the city of Los Angeles. There are, therefore, now available measurements of the run-off for three years, which fortunately include a normal year, a dry year and a very wet year. By comparing these measurements with others on the adjoining westerly slope of the Sierras, where records of the rainfall and stream flow for a period of 16 years are available, it is possible to deduce by analogy the extremes of minimum discharge which may occur in the river and its tributaries during seasons of more acute drouth than the driest of the three in which measurements have been recorded.

After a study of all of these measurements, and of the computations which have been made, we are in agreement with the report submitted to us by the engineers of the Los Angeles aqueduct, that 410 cu. ft. per sec. of water can be depended upon with the regulation of the Haiwee reservoir alone in years similar to those in which measurements have been made upon



MOUNT KEARSARGE FROM INDEPENDENCE. PART OF THE DRAINAGE AREA FOR LOS ANGELES' FUTURE WATER SUPPLY.

*Report (with some omissions) of the Board of Consulting Engineers on the project of the Los Angeles aqueduct from Owens River to San Fernando Valley. The report was dated Los Angeles, Cal., Dec. 22, 1906, and was addressed to the Board of Public Works of the city of Los Angeles. The board consisted of John R. Freeman, Providence, R. I.; Frederic P. Stearns, Boston, Mass., and James D. Schuyler, Los Angeles, Cal., all members of the American Society of Civil Engineers. All the members of the board signed the report.

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thus reducing the time required for the completion of the work, besides effecting a very considerable saving in cost.

(2) The substitution of a high-grade tunnel and conduit line for a siphon, of 15 miles in length, from Little Lake south, using somewhat over 100 ft. of spare fall for that purpose, thereby reducing cost and increasing permanence of construction.

(3) The raising of the elevation of the entire line from Indian Wells to Fairmont about 60 ft. at the lower end and 110 ft. at the upper end, utilizing a further amount of the surplus fall and thus permitting the utilization of the reservoir for storage as a regulator of the power plants to be built on the drop in the canyon.

(4) The elimination of the proposed siphon across Antelope Valley, 11 miles in length, with a maximum head of 400 ft., and substituting a conduit line passing around the head of the valley. This increases the total length of the aqueduct about 21 miles, but effects a saving in head amounting to 60 ft., available for storage and power.

(5) The construction of the long tunnel next to the power drop of the larger dimensions and steeper gradient needed for developing a rate of flow in the hours of maximum power demand, two and one-half times as great as the mean rate of flow, thus largely increasing the amount of power available for sale, and for the development of manufacturing.

(6) We recommend that the conduit and the tunnel and pipe sections have their waterways designed on a somewhat more liberal basis than at first proposed, in order to provide against possible increase of friction with age or the adhesion of organic growths.

We suggest the use of the following co-efficients in the Kutter formula:

For open masonry conduits of cement or smoothly-plastered masonry, $n = .018$.

For concrete-lined tunnels, or covered masonry conduits, $n = .014$.

For steel pipe with rivet heads and seams projecting on the interior, $n = .016$.

For earth canals with bottom as left by dredging, $n = .0275$.

In proportioning the aqueduct between Haiwee reservoir and the San Fernando Valley to convey a mean flow of 410 ft. per sec., including evaporation loss, we recommend and have based our estimates of cost upon a capacity of 5% greater, thus providing for a delivery of 430 cu. ft. per sec. of water, in order that the reservoir might be replenished within 20 days after having been depleted by the interruption of flow in the aqueduct.

In the plans as submitted to us there were several inverted steel siphons of considerable length, aggregating about 33 miles. Some of these we advise should be eliminated altogether and others shortened as much as possible, for reasons both of economy and durability.

There also entered into this question the consideration of the possibility of the steel market being able to afford in a reasonable time such a large order as these siphons would involve. Indeed, it may be said that cutting the distance piped down to the lowest possible distance still leaves a tonnage that may prove troublesome to supply unless plenty of time is given the mills to fill the order.

There is an economic question involved in this matter which will no doubt appeal to your citizens, that, with the exception of the steel in the siphons and the machinery equipments, the entire cost of building, both for material and labor, will be distributed among your own people, if the intention is carried out of producing the cement required.

After a very careful study of all the conditions in detail, this board is of the opinion that all of these changes are desirable, and recommends that they be made.

As a result of our studies, it has been necessary to make new designs of sections of the various types of aqueduct suited for the several localities, to correspond with the steeper grade and the more conservative factors allowed for frictional resistance.

RESERVOIR SITES.—The most important reservoir site on the line of the aqueduct is that next below the intake, as it affords a means of direct equalization of the flow of the main canal and the streams gathered by the canal. The reservoir is situated on a summit in the valley, from which the natural drainage is in both directions, north and south. It has a length of 7.4 miles, measured along the thread of the valley, the south dam being the larger of the two, 70 ft. in maximum height, with a top length of 900 ft. Materials in the vicinity are favorable for the erection of safe, substantial dams of earth at both sites.

The capacity of this reservoir at the elevation of 3,760 ft., as surveyed by Mr. Mulholland, is computed at 63,780 acre feet. By building the dams 10 ft. higher, this capacity may be increased to 82,350 acre-feet, a most valuable increase in storage, although requiring a diminution of the fall in the main feeder canal by 10 ft. in 57 miles. The position of the canal is such that it cannot be raised at the upper end without sacrificing the flow at Blackrock Springs.

Below Blackrock Springs we find this change of gradient of the canal apparently involves no special difficulty, and we recommend that this change receive further consideration.

Fig. 2. Cottonwood Creek, in August, 1906: A Direct Feeder of the Proposed Los Angeles Aqueduct.

The Long Valley reservoir, with a dam 140 ft. high, has a capacity of 260,000 acre-feet, or 85,000,000,000 gals., in round numbers, which is several times the largest existing reservoir in the State. A study of the records of water measurements by the United State Geological Survey for three years on Owens River, and a comparison with longer records of stream flow on Kings River, on the western slope of the Sierras, indicates that when this reservoir is created, the equalization of seasons of extremely large run-off, with that of dry years, will effect a saving of water which is now lost to all useful purposes, amounting to about 80 cu. ft. per sec., in addition to the water controlled by the aqueduct, and owned or appropriated by the city. This addition is necessary to the ultimate securing in years of excessive drouth of the full amount of 400 sec.-feet., for which the aqueduct has been designed.

The board visited the Long Valley dam-site and examined the rock formation of the canyon where the dam would have to be built. The river has cut a deep channel through a volcanic rock classed by geologists as tufa—a rock which is much lighter in weight than granite, but sufficiently strong to be relied upon as a satisfactory foundation for the construction of any type of dam which may in future be decided upon after more careful examination and study of all available materials.

In the opinion of the board a stable and safe dam can be built at this site and the selection of the particular type to be preferred is an economic question which it is now premature to discuss or attempt to decide.

The Long Valley reservoir site, which is chiefly embraced within the limits of the lands purchased by the city of Los Angeles, is admirably adapted to the regulation of the river flow, and the substantial increase of the water supply of the aqueduct by equalizing storage, and should be considered as an essential factor in the general plan, to be developed as early in the future as may be possible. For the reason that this regulation of the river is only required when the demand has reached the maximum aqueduct capacity and to provide against a series of dry years, it has not been included in our estimates or considered as an essential feature of the system for immediate construction.

ESTIMATES OF COST.

The estimates of cost of the Los Angeles aqueduct have been made up of the following general subdivisions, whose leading characteristics have already been described:

FIRST DIVISION.—Headworks on Owens River to Haiwee upper dam, consisting of 115,400 ft. of unlined canal, from 700 to 800 sec.-ft. capacity, and 198,500 ft. of masonry lined canal, of 800 to 900 sec.-ft. capacity. Total length, 313,900 ft. (59.40 miles).

Estimated cost	$3,712,100
Average cost per ft. $11.85	

SECOND DIVISION.—Regulating reservoir with capacity of 63,780 acre-ft.; Elev., 3760.

Estimated cost of dams and accessories, diversion of highway around the reservoir, but not including land damages is..	316,800
Average cost per acre-ft. of capacity. $4.97	

THIRD DIVISION.—Regulating reservoir to Little Lake, a total distance of 81,700 ft. (15.5 miles), through Rose Valley, with a gradient exceeding 1% for the first three miles and 2 ft. per 1,000 for the remainder. This is the first and easiest division of the aqueduct proper, designed to carry 410 sec.-ft. with ample factor for safety, lined throughout and covered where drainage of the country requires to be passed over it.

Estimated cost	481,800
Average cost per lin. ft. $5.90	

FOURTH DIVISION.—From Little Lake to the south end of the siphon crossing of Indian Wells Canyon, a total distance of 127,935 ft., or 24.24 miles, involves the construction of 27,220 ft. of tunnels, 85,000 ft. of conduit lined with masonry and covered throughout, and 15,715 ft. of siphon pipes.

The total estimated cost of this division is.	3,088,400
Average cost per ft. $24.14	

FIFTH DIVISION.—Valley section, Indian Wells to Red Rock Summit, a total distance of 106,000 ft., or 20 miles, consisting of 102,250 ft. of conduit through Indian Wells Valley, with 3,000 ft. of deep cut on Red Rock Summit some 20 ft. deeper than the normal; 1,050 ft. of steel flumes, and 2,700 ft. of siphon pipes, one of which is across the wash leading from Walkers Pass.

The total estimate of this easy division is.	914,600
Average cost per ft. $8.63	

SIXTH DIVISION.—This is a difficult section of 98,600 ft. (18.66 miles), from Red Rock Summit to the Antelope Valley below Pine Canyon, requiring 39,272 ft. of conduit, lined with concrete, 6,000 ft. of flume, 41,700 ft. of tunnels, and 11,628 ft. of siphon pipes, including the crossing of Jawbone Canyon.

The total estimated cost of this section is.	2,760,900
Average cost per ft. $28.00	

FIG. 3. MOUNT WHITNEY, LOOKING UP LONE PINE CANYON.

the Owens River, and that with the further aid of the Long Valley reservoir the 410 cu. ft. per sec. of water can be depended upon in years as dry as any that have occurred upon the adjoining watersheds in the past 16 years.

We have visited the river at the proposed intake of the aqueduct, and one member of this board on Oct. 25, 1906, took a sample of water from the river at the bridge next below the point of intake. This water has been analyzed, and a copy of the analysis follows:

UNIVERSITY OF SOUTHERN CALIFORNIA,
Laird J. Stabler, Professor of Chemistry.
Los Angeles, Cal., Nov. 28, 1906.

Mr. J. D. Schuyler, Los Angeles, Cal.
Dear Sir:

I have analyzed the sample of water delivered by you in a sealed package, with the following result:

	Grains per gal.
Sodium chloride	2.10
Sodium and potassium sulphate	2.21
Sodium carbonate	3.38
Calcium carbonate	4.66
Magnesium carbonate	1.02
Iron and alumina	.56
Silica	.82
	14.75

This is good water for domestic purposes. The alkali forming salts are small, consequently it is good for irrigating purposes. The lime and magnesia salts are present in small quantity; this fact shows the water would not form a bad scale if used in boilers. The water would be fairly soft for laundry purposes.

Yours truly,
(Signed) Laird J. Stabler.

We have been furnished with many additional analyses showing the quality of the water of the Owens River and its tributaries, and of the water now supplied to the city of Los Angeles. A comparison of these shows that the Owens River water is much softer than the water now supplied to the city, which contains from two to three times as much dissolved mineral matter as the water of the Owens River. Our examination of the streams in the Owens Valley showed that the creeks coming from the Sierras furnished water which is clear, colorless and attractive; the water in the river being made up of the combined flow of these creeks is of similar character, but has a slight turbidity and stain, owing apparently to drainage from the marshes in Long Valley and to the other return water from the canals and irrigated lands. This feature would make the water somewhat objectionable if it were to flow directly from the river into the city pipes, but it has little or no significance in the present instance, where the water, after being taken from the river, is to be held for a long time in a large storage reservoir, where the mineral particles which produce the turbidity will have time to settle. The long period of storage in the reservoir will also be an important safeguard against the transmission of disease germs, should any enter the water of the river, because it has been found both by experiment and experience that disease germs are all or nearly all destroyed, where the water is held sufficiently long in reservoirs.

Although the storage of water in a reservoir has a favorable effect in the directions indicated, it sometimes promotes the growth of water plants or algae, which makes the water less palatable and attractive; these growths are liable to occur with any water, and have very little, if any, sanitary significance. It is not feasible to prevent them, but it is feasible to remove their effects by aeration and filtration.

There is an abundance of surplus fall available for aeration below the Haiwee reservoir, where the water will either flow for several miles down the natural bed of the stream, or be discharged with great force against impulse wheels, in either case receiving most thorough aeration. In our opinion, water which has thus been stored and subsequently aerated will be of better quality at its exit from the aqueduct into the San Fernando Valley, than when taken from the Owens River.

OUTLINE OF PLAN OR WORKS.

The plan contemplated the building of an aqueduct of sufficient capacity to deliver a continuous flow of 400 cu. ft. per sec., or 20,000 "miner's inches," as it is locally considered and measured. Starting at the point of intake on Owens River, about 12 miles above the town of Independence, or two miles below a basaltic mound in the valley called "Charley's Butte," the main canal to the Haiwee reservoir, a distance of 60 miles, will have a capacity of 700 to 900 cu. ft. per sec., starting with 700 sec.-ft. and increasing as the side streams are crossed, until Cottonwood Creek is reached, from which point to the reservoir the capacity will be 900 sec.-ft.

This large capacity is provided for the purpose of gathering as much of the flood discharge as is practicable, and conveying it to the main storage reservoir at Haiwee Meadows, whence it is to be drawn at a uniform rate of 400 sec.-ft., plus an additional amount, estimated at 10 cu. ft. per sec., for evaporation losses en route.

For the first 20 miles through the Owens Valley the canal will be sufficiently below the normal water plane, in clayey soil of close texture, to require no lining, but for the lower 40 miles from the point where it begins to skirt along the flanks of the Alabama Hills through to the reservoir it will be lined on the bottom and sides with masonry laid in Portland cement and plastered in a manner intended to prevent a loss of water, thus forming a canal of sufficient stability to withstand all ordinary vicissitudes.

The elevation of the hydraulic grade at the headworks is 3,820 ft. above sea-level, and the proposed high water line of the reservoir is 3,760 ft., giving a total

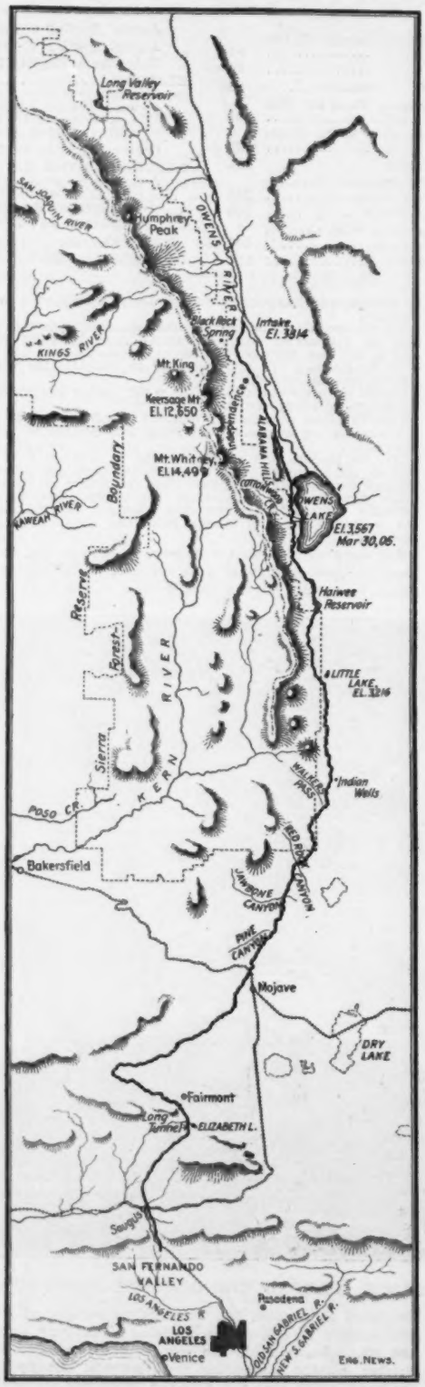


Fig. 1. Map Showing Location of Proposed 226-Mile Aqueduct for the Municipal Water Supply of Los Angeles, Cal.

fall of 60 ft. to the canal, or an average of 1 ft. per mile from the intake to the Haiwee reservoir.

AQUEDUCT FROM HAIWEE RESERVOIR TO THE SAN FERNANDO VALLEY.

From the outlet of the Haiwee reservoir (low water elevation 3,695) to Little Lake, a distance of 15.5 miles, through Rose Valley, there is a total fall of 310 ft. Under the revised plans, 270 ft. of this drop may be made available for power whenever the demands will justify its development. To reduce the immediate expenditures it now appears best to construct this 15 miles in the form of an open conduit, of small section lined with masonry, following the smooth ground in the Rose Valley along the steep natural gradient, thus utilizing the fall to increase the velocity of the water and lessen the size of the conduit. Whenever a demand comes for the development of power in this somewhat remote locality a new line of conduit can be built along the higher elevation, following the contour of the hill at a less steep gradient, thereby saving fall for the development of power. After more complete surveys of the high line it may be found that its additional cost need not defer its construction, especially if there is a prospect of the demand in the not distant future for the 7,000 HP. which can here be developed.

From Little Lake to Indian Wells, a distance by the conduit line of 24.5 miles, is a section of more difficulties than the ordinary, as the line must be supported on the mountain sides at an elevation of 200 to 500 ft. above the valley, along which the highway follows at the base of the Sierra. Here a succession of tunnels, siphon pipes and bench conduits, excavated much of the way in solid rock, and covered from the outset with reinforced concrete, are required. The siphons are eight in number, having a total length of three miles and a maximum head of 150 to 450 ft., while the tunnels have a total length of five miles.

From Indian Wells the line enters upon a section of smooth, open valley land, extending nearly to Red Rock Canyon, a distance of 20 miles, where the excavation will be comparatively easy, with only 3,750 ft. of steel flumes and siphon pipes for crossing dry washes that come out from the mountains.

Beginning at the summit of the ridge dividing Indian Wells Valley from Red Rock Canyon, and extending a distance of 21.5 miles, the second difficult section of the work is encountered, requiring about eight miles of tunnels, 3.5 miles of steel flumes and siphons, and 10 miles of concrete lined and covered conduit. A considerable portion of this distance, however, is through indurated clay, sand and shale, which is not difficult of excavation, although extremely broken in surface topography. In this division the line must be carried across Jawbone Canyon with a siphon pipe having a maximum head of 850 ft.

After passing this broken ground, the conduit emerges upon the smooth plains of the Antelope Valley, where a canal may be built with a minimum of cost, crossing the Southern Pacific Railroad some two miles north of Mojave, and extending entirely around the head of the valley west of Neenach, to a point nearly south of Fairmont. In all this distance of 64.5 miles there are but two exceptions to the unbroken smoothness of the gently-sloping plain, covering a total distance of about six miles. One of these is the crossing of Cottonwood Creek No. 2 with some four miles of indurated sand hills immediately west of it, and the other extends for about two miles along the rolling foothills approaching Fairmont.

The aggregate length of the aqueduct may be summarized as follows.

	Feet.	Miles.	Per cent.
Conduit, unlined canal	117,200	22.20	9.9
Conduit lined with rubble masonry or concrete	868,700	164.53	72.7
Tunnels, in rock	96,295	18.24	8.1
Tunnels, in earth	53,370	10.11	4.5
Siphons of steel pipe crossing canyons	47,460	8.99	4.0
Steel flumes crossing shallow and narrow depressions	9,510	1.80	0.8
	1,192,535	225.87	100.0

The conduit has been estimated with a cover of reinforced concrete for a distance of 100,440 ft., or 11.0% of the entire lined section, the remainder to be left open for the first five years of operation.

MODIFICATIONS OF PLAN.

In a work of this magnitude and on such bold lines, many trial routes must of necessity be surveyed, their cost estimated and their advantages compared before the final line for construction is laid down. In an aqueduct and reservoir project more trial lines are needed than on a railroad project, because of the necessity of following a gradient along which water will flow with velocity rapid enough to prevent sedimentation, and not so rapid as to produce scour, and because of the importance of distributing the fall so as to lessen the diameter and cost of the more expensive portions of the work, and adapt to each type of ground the type of conduit best suited for utilizing the natural resources of the neighborhood in material for concrete and masonry.

Although it is now certain that the best general line of location has been reached, many local variations are still possible, and six or more months of further study by your engineers may well be devoted to this matter of final location.

This board in its studies, and in course of conference with the engineer of the aqueduct, has been led to unanimously recommend the following important modifications.

(1) The substitution of a direct line, thus saving 20 miles in distance over a very rough country and shortening the length of the longest tunnel by about 1¼ miles,

FIG. 4. A MOUNTAIN LAKE OF THE HIGH SIERRAS.

SEVENTH DIVISION.—Antelope Valley from Pine Canyon to the west end of the valley, and to the portal of the long tunnel. Total length of line is 359,200 ft, or 67.81 miles. This division includes 3,970 ft. of siphon pipe, 1,270 ft. steel flume, 475 ft. of tunnel, and 353,485 ft. of conduit lined with concrete.

The total estimated cost is	3,076,000
Average cost per ft. $8.56	
EIGHTH DIVISION.—Long tunnel, 25,000 ft. in length, from portal to portal (4.74 miles).	
Total estimated cost	1,913,200
Average cost per ft. of tunnel $75.33	
NINTH DIVISION.—From the diversion dam in canyon to the point of delivery in San Fernando Valley is a total distance of 80,150 ft., or 15.18 miles, embracing 55,270 ft. of tunnel in earth or sandstone, 9,440 ft. of conduit, 2,240 ft. of flume, and 13,200 ft. of siphons.	
Total estimated cost	1,957,500
Average cost per lin. ft. $24.45	
The total of these subdivisions is a distance of 1,192,525 ft. of constructed line, aside from the Haiwee reservoir length, or 225.87 miles, which is estimated in total at	18,221,300
To this total we add the following:	
For construction railway, telegraph and telephone line, less a reasonable salable value on completion of the aqueduct, based on the scrap value of materials, estimated at $350,000	1,150,000
For cement mill, Mr. Duryee's estimate	300,000
For temporary water supply development for construction purposes and its maintenance during the period of construction	300,000
For fencing aqueduct where left uncovered for first few years and for permanent residences of caretakers	125,000
For engineering and contingencies, 15%	3,014,400
Total	$23,110,700
For land and water rights, and for all legal and other expenses connected with their acquisition from estimates presented by Messrs. Mulholland and Mathews, including what has already been expended, we add	1,375,000
Grand total	$24,485,600

The foregoing estimate of probable cost is made according to our best judgment, using the results of our personal experience, and all the data we have been able to collect of the cost of large works of similar character, but it should be clearly understood that the modifications of the line and grade of the aqueduct proposed by the Board have in some cases carried the new locations beyond the limits of the definitely mapped topography on either side of the located line. In the most difficult sections, however, our revised location has been instrumentally re-examined in detail, and checked. In less important places, where it was manifest that there was no material changes of material within a short distance of the original location, the estimates have been made on the original line, generally parallel with and not far distant from the new line.

In forming our judgment of the cost of excavation, we have been guided in part by our own observations, and in part by the notes of the classification of materials made on the ground by the field engineers.

We have assumed that the cement will be manufactured at a cement mill, to be erected by the city on property already acquired, and that the cost of the cement at the mill will be $1 per bbl., which is substantially the cost as determined by Mr. Edward Duryee, the cement expert, in the employ of the city.

The figures are based upon the assumption that the work will be done on a business basis, unaffected by politics, and with able and honest men in charge of all departments of the work. They are intended to include all money already expended, to safely cover the contingencies and delays ordinarily met with in this class of work, and include an allowance for the extra cost of the work on the eight-hour basis, as compared with the ten-hour basis, on which most of the large engineering works have been constructed, whose cost data are available.

TIME REQUIRED TO COMPLETE THE PROJECT AS OUTLINED.

In our opinion five years is the minimum time in which the projected works can be completed so that water from the Owens River can be delivered into the San Fernando Valley.

The controlling feature in determining the time is the long tunnel, the longest on the line, which will be about 25,000 ft. in length, exclusive of the deep approaches at its two ends, and which must be driven from only four headings, two of which will start from a shaft about 350 ft. in depth, located in the valley. It will take the larger part of a year before work can be actively begun on the tunnel proper, and about four years more for the excavation of the tunnel and for lining it throughout with concrete masonry.

Five years also appears as little time as may be prudently reckoned for the completion of the long series of shorter tunnels in the rugged country between Little Lake and the north end of the Antelope Valley section of the conduit.

Due consideration of economy dictates that work should not be begun on these northerly tunnels until the railroad pertaining to the aqueduct has been extended far enough north to give convenient access to them, and until suitable power plants have been provided, operated either by steam power, or by water power from Cottonwood Creek, transmitted electrically, as may be found most convenient and economical.

While these northerly tunnels are all of them short in comparison with the long tunnel, and any one could be constructed much more quickly, there will be economy in avoiding unnecessary duplication of plant for carrying them all on simultaneously, and five years from the present time appears little enough to allow for completing them all.

The present condition of the labor market and the fact that less work can be accomplished in an eight-hour day than in a ten-hour day must also be taken into consideration in considering those portions of the work outside of the tunnelling.

On certain of the transcontinental railroad extensions now being made to the Pacific Coast, it is reported that much less rapid progress than desired is being accomplished because of the scarcity of labor.

WATER POWER.

There are three localities along the line of the aqueduct where a surplus fall exists that will permit the development of power from water flowing on its course from Owens Valley, to the San Fernando Valley. The most important of these localities is about 45 miles northerly from the city of Los Angeles and a short distance down-stream from the outlet of the Elizabeth Lake tunnel. A total drop of nearly 1,500 ft. is available, and from present indications it appears most advantageous to divide this fall between two power drops, of which the upper one, and the first to be developed, would have about 1,000 ft., and the lower about 415 ft. of net available fall on the water-wheels.

The third site for power development is found a short distance below the end of the aqueduct in the San Fernando Valley. The net fall available at this point would be about 215 ft.

The fourth power site is found near Little Lake, a distance of nearly 150 miles northerly from Los Angeles, and about 15 miles down-stream from the proposed Haiwee reservoir. The net fall available at this point, after relocating the line of the aqueduct between Little Lake and Haiwee, would be about 270 ft.

With an average delivery of 400 cu. ft. of water per sec., there could be developed at these several points, and transmitted to the city of Los Angeles, after making due allowance for the losses in generation and transmission of electrical power, the following amounts, mea-

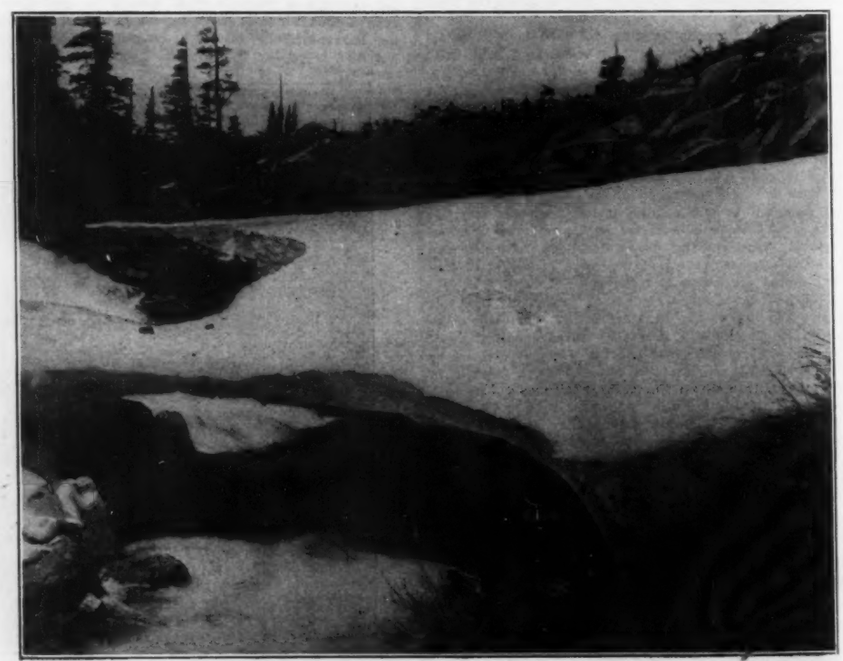


FIG. 5. MELTING SNOW IN A MOUNTAIN GORGE.

sured in 24-hour electrical horse-power at the point of delivery:

From Upper Canyon site	25,000 HP.
From Lower Canyon site	11,000 "
From Fernando site	6,000 "
From Little Lake site	7,000 "
Total	49,000 "

The above would be available 24 hours per day, and seven days in the week.

It is also possible, by means of small and inexpensive dams, to produce small equalizing reservoirs immediately down-stream from each of these two power-houses in the canyon, such that the water for power can be drawn at a rate of flow varying throughout the 24 hours, and that storage can be accumulated over Sunday, while the aqueduct delivers continually at the normal rate of 400 cu. ft. per sec.

Considering that an ordinary factory working 9 hours per day or 54 hours per week, out of the 168 hours, and thus having a "load factor" of 32%, could be supplied with 300 HP. during working hours from the same volume of water that is required for developing 100 HP. continually 24 hours per day, and seven days per week, the great value of equalizing reservoirs and conduits suitable for a higher rate of delivery during the hours of greatest demand becomes apparent. The load factor for future conditions and after the building of more factories may be different from that for present conditions of railway and lighting use.

The Board has for this reason planned the long tunnel and estimated its cost with diameter and gradient such as to permit drawing the water from the reservoir at two and a half times the average rate, or at the rate of 1,000 cu. ft. per sec. during those hours on which the demand for power is greatest.

Under this arrangement it will be feasible to install electrical machinery, and supply power during the hours of maximum use, up to the amount of about 60,000 HP. at the upper power-house, and about 20,000 HP. at the lower power-house.

So far as is shown by the surveys thus far made, it will not be expedient to provide for a large peak load increase at the Fernando power-house, or the more remote power site at Little Lake.

We, therefore, have as the total power that may be developed under the 40% load factor for the two canyon sites, a total of 80,000 HP., and adding to this the 13,000 HP. that may be developed at San Fernando and at Little Lake gives a total of 93,000 HP., measured at the point of delivery in hours of greatest demand, which may be developed from the Owens River water along the course of the proposed aqueduct.

The conditions for the economical development and maintenance of the power are very favorable and its safety against interruption or diminution by drought, and the permanent character of the aqueduct tend to make the power development feature particularly attractive and valuable.

ENGINEERING ORGANIZATION.

We have already indicated the importance of making further surveys and studies to ascertain the best and most economical locations for the aqueduct.

The work of building a water-tight and durable aqueduct, erecting safe and stable dams, and of constructing the great steel siphon pipes which will be required is of a far more exacting character than a railroad construction.

The Los Angeles Aqueduct is a work of such magnitude and extends over so many miles of territory somewhat remote from the base of supplies that it will be a physical impossibility for the chief engineer and the principal assistant engineer to be upon all parts of the work frequently enough to give the quick decision that is necessary for overcoming obstacles. It will, therefore, be essential to have in the field engineers of proved executive skill and resourcefulness, who are expert in the line of work which they are to supervise. We recommend substantially the plan of organization which has been successfully adopted upon the Metropolitan Water-Works of Massachusetts and upon the New York Aqueduct, which is now being prepared for construction. On the Metropolitan Water-Works, representing about the same cost as the Los Angeles Aqueduct, but covering an extent of not more than 60 miles, and where all parts of the line were easily accessible, five of these skilled engineers, known as department engineers, were employed, and all of them were men who had had sufficient experience to enable them to fill a position as chief engineer upon an important work.

In New York, although the work has not yet advanced beyond the preliminary stage, five department engineers of this high grade are now employed. Consulting engineers were also connected with both of these works continuously.

Our recommendation is, therefore, that under the chief engineer and the principal assistant or deputy chief engineer the work be divided into several main departments, each placed in charge of a department engineer having his principal office near the work he is to supervise.

In order to secure suitable men for these positions, it will be true economy to pay liberal salaries sufficient to attract men from other work in these times when the abler engineers are all busy, rather than to take men of less ability and unproved executive skill.

There should be an efficient staff at headquarters to prepare designs for the work of construction and to make the necessary studies and investigations.

The above recommendations are founded upon the experience on similar large aqueducts, where most of the work has been done by contract. If this work is to be done in large part by day labor, a somewhat different organization would be required including men of special skill in several branches of the work.

Our conclusions may be briefly summarized as follows:

(1) We find the project in every respect feasible, and that it involves no great difficulties of engineering or construction other than those arising from mere length and distance.

(2) That a supply of about 400 cu. ft. of water per sec. of good quality for domestic use can be brought to the city of Los Angeles or its vicinity from the Owens River and its tributaries.

(3) That the cost of all water rights, land and structures required for the collection, storage and delivery of this water to the San Fernando Valley, but not including the cost of the future Long Valley reservoir, or those in the San Fernando Valley, or structures required solely for the development of power, will be about $24,500,000.

(4) That from the water conveyed by this aqueduct, power can be developed and transmitted electrically to the city of Los Angeles and vicinity, sufficient to supply 49,000-HP. every day in the year, or a correspondingly larger amount if portions of it are used only during ordinary working hours.

In brief: We find the project admirable in conception and outline, and full of promise for the continued prosperity of the city of Los Angeles.

FORMS FOR CONCRETE CONSTRUCTION.*

By SANFORD E. THOMPSON,† M. Am. Soc. C. E.

Kiln-dried lumber is not suitable for form construction because of its tendency to swell when the wet concrete touches it. Very green lumber, on the other hand, especially Southern pine, which does not close up quickly when wet, may give trouble by joints opening. Therefore, partially dry stuff is usually best.

Eiether tongue-and-groove or bevel-edged stuff will give good results for floor and wall panel forms, and is preferable to square-edged stuff. Even for rough forms, it may be economical to stave plank on one side to reduce the cost of cleaning. Studs should always be planed on one side to bring to size.

The thickness of lumber varies with different contractors, some using 1-in., other 1½-in., while a few employ 2-in. stuff even for panels. (These are commercial thicknesses measured before planing.) For ordinary walls, 1½-in. stuff is good, although for heavy construction where derricks are used, 2-in. is preferable. For floor panels 1-in. boards are most common, although if the building is eight stories high or over, 1-in. stuff is likely to be pretty well worn out before the top of the building is reached, and the under surface of the concrete will show the wear badly. For sides of girders either 1-in. or 1½-in. is sufficient, while 2-in. is preferable for the bottoms of girders. Column forms are generally made of 2-in. plank.

DETAILS OF FORM CONSTRUCTION.

Strength, simplicity and symmetry are three fundamental principles of design. The necessity for strength is obvious. Economy in concrete construction consists in quickly erecting and moving the forms and in using them over and over again.

Concrete members should be designed with a view to economy in forms. A slight excess of concrete may sometimes save carpenter work. Frequently beams may be designed of such widths as to use dimension sizes of lumber without splitting. Columns may be of dimensions to avoid frequent re-making. Recesses may be made the thickness of a board or a plank. To permit ready cleaning of dirt and chips from the column forms before laying the concrete, at least one prominent contractor provides a door at the bottom of each.

In building construction, the forms must be designed so that the column forms and also the bottom of beam forms are all independent of the slab form. The forms may thus be left a longer time upon members subjected to the greater stress.

The sides of the beam forms should be held tightly together by wedges or clamps to prevent the pressure of the concrete springing them away from the bottom boards. Hard-wood wedges at top or bottom of each strut are useful when setting and removing it and also permit testing to make sure that there is no deflection of the beam or slab. For this purpose some contractors loosen the wedges 24 hours in advance of the struts.

*Abstract of a paper read at the annual convention of the National Association of Cement Users at Chicago, Jan. 8-11.

†Consulting Engineer, Newton Highlands, Mass.

Forms for facework should be tightly put together, it being advisable in some cases to close the joints and holes by mortar, putty, plaster-of-Paris, sheathing paper or thin metal. This is not, as is commonly supposed, to prevent loss of strength by the cement which flows out with the water, but rather to prevent the formation of voids or stone pockets in the finished surface.

Crude oil is one of the best materials to prevent adhesion of the concrete to the forms, though linseed oil, soft soap and various other greasy substances are also employed for this purpose. The oil or grease should be thin enough to flow and fill the grain of the wood. If the forms are to be left on until the concrete is hard, there is little danger of the concrete sticking to them if they are wet thoroughly with water before the concrete is laid, instead of being greased. If concrete adheres to the forms it should be thoroughly cleaned off before resetting; even then it is apt to stick again in the same place.

DESIGN OF FORMS.—"Rule of thumb" layout of forms in the field is being superseded by design in the drawing room. Many of the best concrete contractors now design their forms as carefully as the dimensions of the concrete members.

In ordinary walls where the concrete is placed in layers, computation is not usually necessary, since general experience has shown that maximum spacing for 1-in. boards is 2 ft., for 1½-in. plank, 4 ft., and for 2-in. plank, 5 ft. Studding generally varies from 2 × 4-in. to 4 × 6-in., according to the character of the work and the distance between the horizontal braces or waling.

Floor forms are better based upon an allowable deflection than upon strength, in order to give sufficient stiffness to prevent partial rupture of the concrete or sagging beams.

In calculating, we must add to the weight of the concrete itself (that is, the dead load) a construction live load which may be assumed as liable to come upon the concrete while setting. Definite units of stress must also be assumed in the lumber. I would suggest the following basis for computation, these being values which I have adopted after quite thorough consideration of the matter:

(1) Weight of concrete, including reinforcement: 154 lbs per cu. ft.

(2) Live load. 75 lbs. per sq. ft. upon slab: 50 lbs. per sq. ft. in figuring beam and girder forms.

(3) For allowable compression in struts use 600 to 1,200 lbs. per sq. in., varying with the ratio of the size of the strut to its length. (See table below.) If timber beams are calculated for strength, use 750 lbs. per sq. in. extreme transverse fiber stress.

(4) Compute plank joists and timber beams by the following formulas, allowing a maximum deflection of ⅛-in.

$$d = \frac{3}{384} \cdot \frac{W l^3}{E I} \quad \text{.....(1)}$$

$$\text{and } I = \frac{b h^3}{12} \quad \text{.....(2)}$$

in which

d = greatest deflectoin in inches.
W = total load on plank or joist.
l = distance between supports in inches.
E = modulus of elasticity of lumber used.
I = moment of inertia of cross-section of plank or joist.
b = breadth of lumber.
h = depth of lumber.

The formula is the ordinary formula for calculating deflection except that the coefficient is taken as an approximate mean between $\frac{1}{384}$ for a beam with fixed end and $\frac{5}{384}$ for a beam with ends simply supported.

For spruce lumber and other woods commonly used in form construction, E may be assumed as 1,300,000 lbs. per sq. in.

Formula (1) may be solved for I, from which the size of joist required may be readily estimated.

The weight of concrete per cubic foot is somewhat higher than is frequently used, but is none too much where a dense mixture and an ordinary percentage of steel is used. For very rough calculation, however, it is frequently convenient to remember that 144 lbs. per cubic foot is equivalent to the product of the dimensions of the section of a beam in inches times a length of one foot.

The suggested live load is assumed to include the weight of men and barrows filled with concrete and structural material which may be piled upon the floor. It does not include, however, the weight of piles of cement or sand or stone, which should never be allowed upon a floor unless its weight is supported by concrete sufficiently strong to bear the weight, or by struts under all the floors below.

The units for stress in struts are somewhat higher than in timber construction because the load is a temporary one. The extreme variation given is due to the fact that when a column or strut is longer than about 16 times its smallest width, there is a tendency to bend which must be prevented either by bracing

bears about the same relation to concrete that bronze does to marble. Of course railings of wrought iron and steel would be permissible.

In this connection I wish to call your attention to the heavy balustrades and parapets of concrete used on light concrete bridges. This is particularly noticeable on flat reinforced-concrete arch bridges, whose beauty depends solely upon their correct proportions. A plain metal railing would frequently give a better balance and scale, and relieve the structure of the appearance that its sole duty was to support the parapet. Not infrequently you will see the coping, at the level of the bridge roadway, brought almost tangent to the extrados of the arch ring, giving an effect somewhat as suggested in sketch I of Fig. 1—and then this weak structure is loaded down with a heavy parapet. Of course, clearance occasionally demands that the coping be so placed; but when it does not, put it from 1 to 5 ft. above the crown of the arch or use a lighter railing.

On the other hand, a massive bridge needs a heavy parapet.

The use of keystones is deprecated, especially for reinforced-concrete arches built monolithically. They are without meaning.

I wish also to call your attention to the fact that heavier details—stronger projections—are required in concrete than in similar stone work. This, you will readily appreciate, is due to the fact that the arrises are not as fine as in the latter material. This is of particular import in a structure of great height.

Even more important, because necessitated by the requirements of good workmanship, is the shape given to projections and recesses. Sketch II of Fig. 1 brings out graphically the difference between stonework and concrete-work in this matter; the left-hand view shows a stone section, the right-hand one a concrete section, both of the same general outline. The conditions surrounding the practical execution of concrete work require the heavy rounding of corners and strongly battered wash and draft slopes shown. The same principle applies to depressions, grooves, etc., as for instance the false joint-notches in rusticated work. Various ways of shaping these details are open to the designer; three of them are illustrated in sketches III, IV and V of Fig. 1. In the former, heavy rounding is used, to produce safe corners; in the second, the notch is triangular, with an angle of about 90°, giving perfectly free draft; in the third, the original square notch is modified by giving the sides such a batter that the lagging will draw away freely without risk of damaging the corners.

Besides having sufficient draft for free removal of forms, all rëentrant angles must be shaped with due regard to the flow of concrete around the projections of the forms. In sketch VI of Fig. 1 is shown an arch skewback with the end portion of the arch. If the arch concrete and the skewback concrete are to be placed at the same time, the concrete can reach face BB only by flowing around the projecting corner of the form, and if this corner is too acute an angle an imperfect surface at BB may result. It is important therefore to give face BB such a slope that the concrete can be forced against the form by the pressure of the concrete above. As shown in sketch the slope of BB is a little too flat, and should be made steeper. The same considerations affect the design of the coping shown in sketch VII, Fig. 1. If the slope of the coping is made as shown by the full lines, the forms can be built only as far as line a-a, in order to permit of tamping the concrete under the top of the coping form; and the concreting must then be stopped until the forms for the parapet are erected. By sloping the upper surface of the coping as shown by the dotted lines, the concrete will be able to give a good face against a top form, so that the parapet can be concreted at the same time as the spandrel wall and coping.

WATERPROOFING AND EXPANSION.—In waterproofing a flat surface I have to call attention to the loose skin method, which is probably as good as any other in use. This method consists of placing shingled layers of waterproofing paper, cemented together by a waterproofing composition, upon the surface of the concrete, without having the lower layers of the paper covering adhere to the concrete. The theory of this is, if the concrete cracks—and it generally does—the waterproofing layers will not crack with the concrete.

The engineer should try to localize the cracks by proper expansion joints and provide for these expansion joints in the waterproofing scheme. As

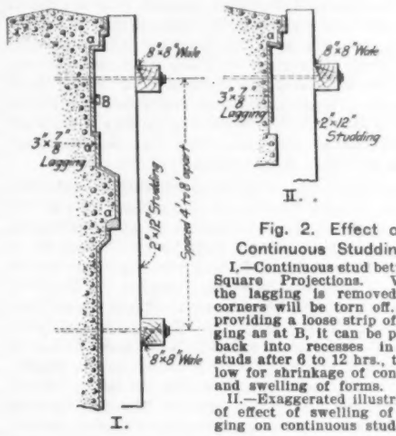


Fig. 2. Effect of Continuous Studding.

I.—Continuous stud between Square Projections. When the lagging is removed the corners will be torn off. By providing a loose strip of lagging as at B, it can be pulled back into recesses in the studs after 6 to 12 hrs., to allow for shrinkage of concrete and swelling of forms.

II.—Exaggerated illustration of effect of swelling of lagging on continuous studding.

in retaining walls, the best safeguard against leakage is to get the water away by drainage slopes, French drains, etc., bearing in mind in waterproofing that water takes the line of least resistance.

Expansion joints in retaining walls should be carried down to the foundation bed. It is not uncommon for engineers to start their expansion joints a few feet below the surface of the ground and not to carry them down to the foundation bed. This will often prove disastrous to the effective working of the expansion joint.

Face Work.

Wherever the funds permit, concrete surfaces should be tooled, for appearance, excepting in very large structures where the imperfections on untooled concrete would not be noticeable.

When forms are removed the concrete surface is as a rule unsightly. Parts of the structure executed upon different days, under different foremen, with sand and rock varying in color, show a decided difference in color. Also such parts of the structure as are laid up by dissimilar methods show a similar variation—for example, work which is cast against a form will have a different color from work composed of exactly the same kind of materials which has been trowelled in place; you will often notice this difference in color of coping and vertical wall. If forms are not oiled or soaped the knots will discolor the concrete, the print of each knot being clearly marked on the surface of the concrete in a brownish color. If they are oiled with a fatty oil, the oil will be in part absorbed by the concrete, making additional stains. Marks of the lagging are unsightly and the imprints of the grain give a woody appearance to the structure. The lipping of the different days' work make the work appear ragged and this is added to by the roughness of the edges. You will also find the face is slovenly as a rule, and pitted with small water holes. Last but not least we have efflorescence.

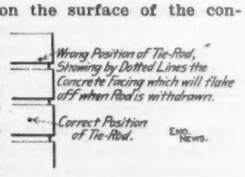

Wrong Position of Tie-Rod, Showing by Dotted Lines the Concrete Facing which will flake off when Rod is withdrawn.
Correct Position of Tie-Rod.
Eng. News.

Fig. 3. Sketch Illustrating Proper and Improper Location of Tie-Rods with Respect to Face Details.

These defects are frequently obliterated in part by giving the structure a grout wash or a thin veneer of mortar. This method has been previously referred to, and in my judgment would better be omitted. The grout wash as a rule gives the appearance of paint carelessly applied and the thin veneer, unless applied by an expert hair-cracks and frequently, after a few years, peels off.

It is also common practice to wash the surfaces, using water and an ordinary scrubbing brush. This removes most of the bad effects, and, when in addition the edges are filed, presents a neat appearance, provided, however, the structure is built or at least faced with fine-stone concrete. The objection to this, however, is that the lagging must be removed in from 12 to 24 hours, depending upon the nature of the cement and other conditions governing time of setting—requiring especial care in the construction of the forming and adding considerably to the cost. On a small structure, a park bridge, for instance, the added cost should not be considered, as the effect is good; but in large structures, where the contractor's profit depends upon his ability to keep his concrete plant working, this added work in building the forms and the added work of their speedy demolition would, I believe, entail considerable cost.

Several years ago the District of Columbia built a small concrete bridge over Broad Branch,* of gravel concrete, the surface of which was washed as described and which gave a good effect.

The best way, however, of obliterating the unsightly appearance of unfinished concrete is to tool it, using a bush-hammer, crandall, point or pick, and using a chisel or file for the arrises. The spandrel walls of the Piney Branch bridge† now under construction are being tooled, using a small pick for this purpose. The effect is rustic and I believe pleasing. The concrete trimmings of the Connecticut Ave. bridge are being bush-hammered and the balance of the structure is being crandalled.

In dressing concrete surfaces, especial care should be taken to use sharp tools, otherwise the arrises will be bad, the surfaces will be marked with unsightly holes (caused by loosening stones, by dull tools) and the surfaces will be lifeless.

BLOCK FACING.—It is not necessary to plaster the backs of facing blocks or stones with cement mortar. This went out of fashion when wet concrete came in. Neither is it necessary to wet the backs of these blocks or stones, if you are backing up with wet concrete.

Forms.

In designing forming for finished concrete cast in place, the designer should be careful not to use long, continuous studs cut out to the profile of the work as shown in sketch I of Fig. 2; if he does, it will be impossible to get the forming off without ruining edges a, a, a. The forms will be wedged tight at these points, as you will readily see. This wedging is due to the load of the concrete which is molded against the forms, and is made worse by the swelling of the lagging and studs caused by the water in the concrete. Sketch II, Fig. 2, shows an aggravated case of the swelling of the studs and lagging; you will note that the lagging is forced into the concrete so that corner "a" is sure of being broken when the forming is removed. To prevent this, in part at least, the following precaution is a good one: At every 3 ft. vertical, in a day's work, cut a piece of lagging into three parts as shown at B in sketch I. Then notch out the studs so that the middle portion of the lagging can be removed at any time by pulling back into the notch provided for it in the stud. When the concrete is six to twelve hours old, the middle slip should be pulled back as suggested. This is, I believe, an innovation of Mr. James Overn, C. E.

The use of short studs, with small wedges at dangerous corners, will prevent the troubles just referred to.

In designing forms, care should be taken to locate the forms in such a way that tie-rods will not come closer than 4 ins. to a projecting corner or other detail. If a rod is very close to a small detail there is a great chance of the concrete spalling off when the tie-rod is withdrawn

*Illustrated and described in Engineering News of Jan. 22, 1903, p. 70.

†Engineering News, Nov. 16, 1905, pp. 510-512, and April 19, 1906, p. 453.

it both ways or allowing a smaller load per square inch. Bracing both ways will of course reduce the length of a long strut. For struts ordinarily used the following stresses may be assumed for different heights:

Safe Strength of Wood Struts in Forms for Floor Construction.
(Lbs. per sq. in. of cross-section.)

Length of strut.	Dimensions of Strut— 3 × 4 ins.	4 × 4 ins.	6 × 6 ins.	8 × 8 ins.
	lbs.	lbs.	lbs.	lbs.
14	....	700	900	1,100
12	600	800	1,000	1,200
10	700	900	1,100	1,200
8	850	1,050	1,200	1,200
6	1,000	1,200	1,200	1,200

If the concrete floor is comparatively green, the load must be distributed by blocking, preferably of hard wood. At the top of the strut provision must be made against crushing of the wood of the plank or cross-piece. Ordinary soft wood will stand only about 700 lbs. per sq. in. across the grain, so if the compression approaches this figure, brackets must be inserted or hard wood cleats used.

TIME TO REMOVE FORMS.—The best contractors have definite rules for the minimum time which the forms must be left in place in ordinary weather, and then these times are lengthened for changes in conditions according to the judgment of the foreman. Correspondence with a number of prominent contractors in various parts of the country indicates substantial agreement in the minimum time to leave forms. As a guide to practice, the following rules are suggested:

Walls in mass work: one to three days, or until the concrete will bear pressure of the thumb without indentation. Thin walls: in summer, two days; in cold weather, five days. Slabs up to 6-ft. span: in summer, six days; in cold weather, two weeks. Beams and girders and long span slabs: in summer, ten days or two weeks; in cold weather, three weeks to one month. If shores are left without disturbing them, the time of removal of the sheeting in summer may be reduced to one week. Column forms: in summer, two days; in cold weather, four days, provided girders are shored to prevent appreciable weight reaching columns. Conduits: two or three days, provided there is not a heavy fill upon them. Arches: of small size, one week; for large arches with heavy dead load, one month.

All of these are, of course, simply approximate, the exact time varying with the temperature and moisture of the air and the character of the construction. Even in summer, during a damp, cloudy period, wall forms sometimes cannot be removed inside of five days, with other members in proportion. Occasionally too, batches of concrete will set abnormally slow, either because of slow-setting cement or impurities in the sand, and the foreman and inspector must watch very carefully to see that the forms are not removed too soon. Trial with a pick may assist in reaching a decision. Beams and arches of long span must be supported for a longer time than short spans because the dead load is proportionately large, and therefore the compression in the concrete is large even before the live load comes upon it.

Frequently on small work with only one mixer the contractor would make money by placing the richer concrete throughout. I recall one design of my own where three mixtures were specified, where the leanest mixture was amply strong. This sort of thing doesn't cost your client any more, as a rule, because the contractor in making his bid doesn't have time to consider these hair-splitting points—but it costs him (the contractor) money that he hasn't figured upon.

FOUNDATION CONCRETE.—On foundation work where mass is desired and reinforced concrete is not practicable, and where the supporting foundation bed will not safely stand more than two or three tons per square foot, a cheaper and frequently equally good foundation may be obtained by using a cheaper aggregate than first-class concrete stone. Broken brick, broken concrete, the softer varieties of rock, slag and cinder may be safely used for this class of concrete. In deep massive concrete foundations the weight of the foundation is often one-half

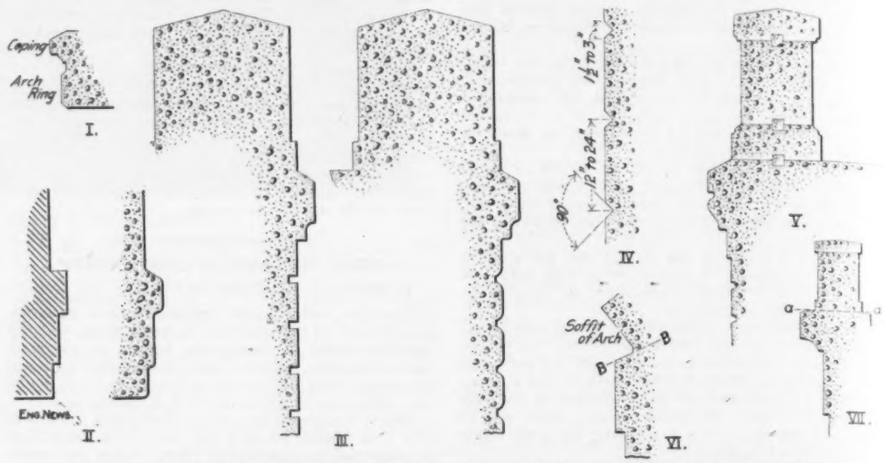


FIG. 1. SKETCHES ILLUSTRATING SPECIAL POINTS IN DETAILING CONCRETE.

I.—Crown Section of Concrete Arch: Corners rounded or beveled. Depth between ring and coping too low for apparent strength.
II.—At left, right-angle work, suitable for stone but poor detail for concrete; at right, proper detail for concrete.
III.—At left, sharp corners, and "rustic" joints too deep for proper casting. at right, all corners rounded, good concrete detail.
IV.—V-shaped "rustic" joints; good concrete detail.
V.—Joints with sides sloped to allow easy removal of forms. Coping of parapet cast on ground, top down, and set in place.
VI.—Arch skewback; the slope of wash B-B should be steeper to cast well against a top form.
VII.—If bevel of coping is changed as shown by dotted line, it will cast well against a top form, and the parapet can be concreted at the same time as the wall.

PRACTICAL HINTS FOR CONCRETE CONSTRUCTORS.*

PART II.

By W. J. DOUGLAS.†

Some Points in Detail Design.

VARIETY OF MIXTURES.—In your plans and specifications for small work, don't call for two or three different mixtures of concrete where it is not necessary. You are figuring pretty close when you differentiate between, say, 1-2-4, 1-2½-5 and 1-3-6 mixtures. It is axiomatic that a 1-2-4 is stronger than a 1-3-6, other things being equal, but is the practical difference so great that you cannot safely get along with a 1-3-6, or is the added cost of the material of the 1-2-4 really a matter of monetary import? If you study the ultimate crushing strength of the several classes of concrete, you will probably conclude that the practical difference as to compression is not great. I do not mean to say that you should not use a 1-2-4 for reinforced-concrete work or other high-stress design; but on plain, every-day work you will often find a 1-2-5 or 1-3-6 is amply strong for an entire job. In foundations you can frequently use a 1-3-7, 1-4-8 or 1-5-10 in perfect safety if you have good materials and good inspection. If you can in safety do so, specify one lean concrete for your foundations, say 1-4-8, and use a 1-2-5 (or depending on your aggregate a 1-2½-5) in your superstructure.

the total weight which comes on the supporting bed.

In this connection attention should be called to the use of concrete piles for foundations which have to be carried to any great depth, particularly where water is to be encountered. In many cases I think the concrete pile will be found the cheaper foundation.

REINFORCEMENT.—In all designing in concrete, care should be taken not to suddenly change the cross-section from a heavy one to a thin one unless this is imperative. All quick changes from heavy to light section should be reinforced with steel. The greater the change, the greater amount of reinforcement is needed. Concrete in setting up acts a good deal like cast-iron does in solidifying and cooling, and the concrete designer should bear in mind this bad trait. In an article* by the writer on the Connecticut Ave. bridge, Washington, D. C., this trouble was exemplified in a small detail, which had to be changed for the reason noted; in this particular case, had we adhered to the original cross-section of the detail, I do not believe that any amount of reinforcement would have overcome the difficulty.

Abutments of U-shape built of unreinforced concrete frequently crack at or near the intersection of the wing-walls with the head wall. These cracks are caused by the outward rotation (in directions at right angles to each other) of the head wall and the side walls. The pressure at the toe of these walls being greater than at the heel, their outward rotation is evident, assuming the foundation bed to be compressible. The stresses engendered by this outward rotation are amplified by the bending of the walls considering them as cantilevers, fastened at the foundation. I noted recently in a wall 60 ft. high, designed on the basis of a base four-tenths the height, that the flexure amounted to about ¼-in. (Whether this was all due to flexure is problematical, not certain, although knowing the nature of the foundation bed I believe the movement was one of flexure.) The shearing and tensile strains caused by this combination of rotation and flexure, added to often by the unequal settlement of the foundations, cannot be resisted by unreinforced walls of ordinary thickness. Therefore I suggest heavy steel reinforcement at this junction of the walls, even when the walls themselves are not built of reinforced concrete.

If you can't afford to do this I would use tie-rods joining the side walls or I would build the head wall detached from the side walls. The lip which will form between the head wall and both of the side walls may be dressed off or be hidden in the design.

AESTHETIC DETAILS.—If a structure is not to be tooled or finished by other means, its design should be simple in its architectural details, the beauty of the structure in this case being made to depend on the harmony of proportion. Such a structure should have filleted corners and well rounded details, simple moldings and large details in general, so that it will stand out boldly a confessed simple concrete structure. The excellent Thebes bridge approaches* and the Big Muddy bridge† are good types of this class of concrete structure. Both of these bridges are in thinly settled districts, and fine details, particularly for a railway bridge, would be marks of poor design.

Occasionally one sees a concrete bridge in which fine marble details are attempted [in many such cases the concrete is not tooled, and if you examine the structure you will find the balusters rough, their edges and corners broken, other edges ragged and thick, the base and top rail warped with unsightly edges, and the mortar joints varying between 1/16-in. and ⅛-in. to take up errors in casting], and in harmony with a marble design the lamps and other metal ornaments will be of bronze. This in my judgment is unfortunate. These finely wrought metal details can only succeed in showing how futile it was to attempt the fine details in concrete. Cast-iron is the best metal to use for such work. It

*Copyrighted, 1906, by Engineering News Publishing Co. Part I. was published in Engineering News of Dec. 20, 1906.
†Engineer of Bridges for the District of Columbia, Washington, D. C.

*Engineering News, June 1, 1905, pp. 571-575.

*Engineering News, May 11, 1905, pp. 479-483.
†Engineering News, Nov 12, 1903, pp. 423-429.

REPORT ON A COMBINED REFUSE DESTRUCTOR AND ELECTRIC LIGHTING PLANT FOR EAST ORANGE, N. J.

The city of East Orange, N. J., being in sore need of some improved means of refuse disposal, and at the same time inclining strongly to the belief that municipal ownership of a street lighting plant would be desirable, recently took the very sensible step of referring both these matters to an engineer for investigation, with instructions to consider the possibility of using heat from a refuse destructor to reduce the fuel bill of an electric lighting plant. For this purpose Mr. Henry Floy* was engaged. After an investigation, in which he was assisted by Messrs. Louis B. Marks, Illuminating Expert, and E. G. Ackart, Mechanical Engineer, Mr. Floy reported to the East Orange authorities on Nov. 20, 1906. He advised the substitution of a municipal electric lighting plant for the present system of gas lighting under private contract, unless the greatly increased service recommended by him can be secured by a private company at a comparatively small advance over the cost of the present inadequate service. He also advised that, regardless of the electric light question, "a plant for the destruction by fire of all or a part of the city waste" be erected; that at least the garbage and rubbish be burned, "preferably utilizing the heat of the waste gases;" and that in addition to the garbage and rubbish the ashes also be burned, "provided the heat generated by such disposal can be utilized." From a strictly financial standpoint Mr. Floy concluded that the utilization of ashes as fuel would be utterly unwarranted, since the same amount of steam could be raised from coal at much less cost; nor did he believe the sanitary value of burning the ashes sufficient to warrant the expense unless the resulting heat could be utilized, and the cost thus reduced. As to the garbage and refuse, he was of the opinion that an actual reduction in the expense of burning could be effected by utilizing the heat.

Perhaps we should state, before giving an abstract of the report, that East Orange is a suburb of New York, and that its population by the New Jersey State census of 1905 was about 25,000, an increase of some 3,700 over the population shown by the United States census of 1900.

The city ordinances of East Orange provide that householders must separate refuse intended for collection into three classes: garbage, rubbish (paper, wood, rags, etc.) and ashes. Although the report does not make the point clear, it appears that in the collections and final disposal the rubbish and ashes are mixed. Collections of the various classes of refuse are made by one public and nine private scavengers. The public scavenger is paid by the city, under two contracts. One of these, which runs to Aug. 1, 1911, provides for the collection and removal at least every other day (Sundays excepted) of all garbage and refuse placed in receptacles at the front of any premises, and of all dead animals; the garbage and dead animals to be deposited at points designated by the city. The contract price for this service is $13,400 a year, less a small deduction for short hauls. The second contract, which will expire on Aug. 1, 1907, entitles the contractor to $3,000 a year for delivering the garbage to a reduction plant outside the city [on the Passaic River, Newark.—Ed.]. It is estimated that the nine private scavengers are paid a total of $15,000 a year for their services. The former cost of the public service, under the two contracts just outlined, was $8,333 per year, for the three years ending July 31, 1906; from which it can be seen how the cost of the service is increasing. Refuse disposal outside the city, the report states, is barred by all but one of the surrounding municipalities. Refuse other than garbage is used to fill low land, at points within the city named by the authorities. As East Orange is already closely built these "dumps" are becoming increasingly objectionable.

No records of the amount of refuse collected in East Orange being available, Mr. Floy was obliged to make such estimates as he could, based on interviews with scavengers, personal observations and "absolute quantities and weights for certain periods." These indicate a total of 14,940 short tons per year of garbage, rubbish and ashes, or 40.83 tons per day, the daily average ranging from about 50 tons in winter to 34 tons in summer. The total yearly garbage collection is placed at 3,420 short tons, or an average of 9.37 tons per day, with a maximum of 17 tons in summer and 5 tons in winter. The rubbish [collected with the garbage] is estimated at 6.4 tons and the ashes alone at 25 tons, both a daily average for the calendar year.

Mr. Floy dismissed from detailed consideration the burning of garbage alone on account of:

(1) The high cost per ton, resulting from the necessity of using fuel, and the small quantity collected during the winter months.
(2) The solution of only a part of the question of waste disposal.
(3) The ill success of this method elsewhere.

As already stated, the cost of refuse collection [by the public scavenger] is fixed until Aug. 1, 1911, regardless of the method of disposal. In estimating the cost of burning the refuse, allowance is made for an increase in future quantities over the estimates for present quantities already given, and it is further assumed that duplicate installations will be provided, either one capable of dealing with the daily collections. This would permit operation for two instead of three eight-hour shifts per day, and also shutting down for cleaning and repairs on Sundays. No charge for removing clinker and ashes was included, it being thought that contractors would remove these at least without charge, in view of the sale of such material abroad, and the market price of $2.50 per load, in East Orange, for "clean ashes used for filling and making sidewalks."

The accompanying table shows Mr. Floy's estimates of the comparative capital outlay for a plant to burn garbage and rubbish, and one to burn these materials and ashes. The table also shows the daily capital and operating charges under the same two propositions.

Table I.—Comparative First Cost and Total Yearly Expense of Furnaces for Burning Garbage and Rubbish Alone and Garbage, Rubbish and Ashes: East Orange, N. J.

Incinerators for garbage and rubbish.	
2 30-ton Incinerators	$34,000
Building, stack, etc.	18,000
Real estate	3,500
Engineering and contingencies	5,550
Total	$61,050
Interest at 4% and depreciation at 5% (per day)	$13.80
Cost of incinerating an average of 15.77 tons at 50 cts. (per day)	7.88
Total cost per day	$21.68
Total cost per year	*$7,913.00
Approx. total cost per ton	*$1.35
Destructors for garbage, rubbish and ashes.	
2 60-ton Destructors	$53,000
Building, stack, etc.	21,000
Real estate	3,500
Engineering and contingencies	7,750
Total	$85,250
Interest at 4% and depreciation at 5% (per day)	$19.48
Cost of destroying an average of 40.83 tons at 50 cts. (per day)	20.41
Total cost per day	$39.89
Total cost per year	*$14,560.00
Approx. total cost per ton	*$1.00

[*These figures have been added for the convenience of the reader.—Ed.]

The conclusions (slightly condensed) of the part of the report relating to refuse disposal are as follows:

(1) From the figures given above for costs of incinerating garbage and rubbish, it will be seen that the total annual charge for such disposal will amount to $7,912. Against this charge may be credited the cost of present garbage disposal, $3,000 (as per the terms of the existing contract) and something additional, say, $250, saved by difference in haul (as per the terms of the existing contract). With these deductions it will be seen that:

(2) The apparent annual increased cost for disposal of garbage and rubbish by incineration will be $4,622, as compared with the expense of the present system, ignoring the possibility of garbage disposal outside of the city being absolutely prohibited, or the probable increased cost therefor after Aug. 1, 1907, or the possible profitable use of the heat of combustion for extraneous purposes.

By figuring the results to be obtained from the incineration of garbage and rubbish, as has been done on the following pages for garbage, rubbish and ashes, it may be shown that probably about $1,000 per annum may be credited to the above cost of garbage and rubbish incineration, provided the heated gases can be used in generating steam for extraneous purposes, therefore:

(3) The annual cost for incinerating garbage and rubbish, compared with present expenses, will be $3,622, provided advantage is taken of the heat to be derived from the products of combustion.

From the figures given in Table I., the writer concludes that:

(4) Considering the destruction of East Orange waste, only from a financial standpoint, without regard to sanitary advantages, or the possibility of utilizing the superfluous heat, it would not be advisable to consider destroying by fire anything more than garbage and rubbish.

If ashes are burned with the garbage and rubbish, sufficient steam may be produced to make practicable its use for extraneous purposes; whether the amount of steam so produced is of sufficient value to recompense the increased cost of destruction of combined waste, depends chiefly upon the fuel value of the ashes collected.

The figures in Table II. [Omitted.—Ed.] have been deduced in order to compare the calorific values of average English and East Orange combined waste. The figures for the English waste were accepted as representative by the International Engineering Congress at St. Louis in 1904.

Owing to the fact that the English waste contains a larger amount of unburned fuel in the ashes and less moisture in the garbage than does the East Orange waste the fuel value of the English waste is considerably higher than that of East Orange waste. This, of course, means that a pound of English waste will produce, as shown by the figures, about 25% more heat than one pound of East Orange waste.

Table III. [Omitted.—Ed.] has been calculated to show the equivalent pounds of coal that might be saved by the combustion of combined East Orange waste. "Equivalent evaporation" is the proportionate amount of water evaporated per pound of East Orange waste compared with 1½ lbs. of water, which has been taken as the conservative quantity of water that would be evaporated from and at 212° F. by 1 lb. of average English waste. (English destructors on test have repeatedly shown an evaporation from and at 212° F. of over 2 lbs. of water per pound of waste.)

The "apparent value" is based on an evaporation of 8 lbs. actual, or 9.3 lbs. from and at 212°. The net coal value of the total East Orange waste, for a year of 365 days (1,150 long tons) is available for extraneous uses, 15% having been deducted from the "apparent value" for destruction requirements. Including delivery, steam coal in East Orange costs $2.70 per ton, at which rate the total waste for one year, 1,150 tons, is worth $3,130 as fuel. But, as shown in Table I., the additional cost of destroying combined waste, including labor and fixed charges, as compared with the destruction of only garbage and rubbish, amounts to $18.21 per day, or $6,646 per year. The fuel value of garbage and rubbish combined being about $1,000 per annum, and that of garbage, rubbish and ashes, $3,130 per annum, there results a net value of $2,130 from combined destruction, but the increased cost of securing the latter being $6,646, the difference $4,516 is the actual increased cost to the city for destroying combined waste, provided the steam produced by said destruction can be advantageously used.

From the above figures the writer also concludes that:

(5) Considering the destruction of East Orange combined waste, only from a financial standpoint, without regard to sanitary conditions, but taking advantage of the fuel value of combined destruction, it will cost the city about $4,500 per annum, as compared with incineration of only garbage and rubbish, and therefore, combined waste destruction is inadvisable.

(6) Considering destruction of combined waste from the standpoint of sanitation, convenience and future necessity, such destruction is advisable, provided the fuel value of the waste can be utilized, as the increased financial obligation would not amount to more than $4,500 per annum.

(7) The destruction of combined waste, without the possibility of utilizing its fuel value, is inadvisable, as the increased financial obligation of about $7,000 per annum, compared with garbage and rubbish incineration, will hardly compensate at present for the advantages to be secured.

The section of the report devoted to street lighting need not be considered in detail here. Mr. Floy considered that the city was very unsatisfactorily lighted by gas, even where Welsbach burners are used, and recommended electric lighting, with underground distribution. He assumed, however, that an electric lighting plant would not be erected by the city, independently of a refuse disposal plant. The estimated coal bill without heat from a refuse destructor is $7,030 a year. The fuel value of garbage and rubbish ($1,000) would reduce this to $6,030 a

*Consulting Engineer, 220 Broadway, New York City.

from the concrete. The sketch Fig. 3 is an illustration of a bad case, where the tie-rod was located too close to the edge of a rustic joint.

Materials and Construction Work.

CEMENT.—Paper cement bags are not cheap as a rule. You can't chute cement furnished in paper, nor handle in any other practical manner, without injuring a large percentage of it. In addition to this, the great number of leaky bags are cause of contention between the foremen and inspectors.

SAND AND STONE.—Mesh determinations of sand and run of crusher concrete stone are useful to the engineer in passing on these materials.

Concerning the sand test described in my former article (Dec. 20, 1906), I might add that the pin is fastened horizontally to the end of a stick or wire. When it is lowered into the water the murkiness of the water tends to obscure the pin, and the deeper the pin the more it is obscured, until a point is reached when the pin passes out of sight (viewed from the top). Just when the pin reaches this point, its position with reference to the graduation on the beaker is to be determined by reading from the side.

LARGE STONE INCLUSIONS.—The use of large stone in concrete is thought to be excellent in mass work, particularly for dams where weight and horizontal shear are factors. Further, their emplacement frequently results in less cost per cubic yard.

The methods of placing these large stones differ in nearly every community. In some cases the restrictions of the engineers are so great that the result is an additional cost rather than a saving. It is not necessary to plaster these stones, nor bed them in mortar, if they can be *dropped* into the work before the concrete is set. Neither is it necessary to select flat stones (in highly stressed concrete this may be a matter of argument) for this work.

The stones should be clean, far enough apart to be well encased in concrete, and the encasing concrete should be wet so as to be stamped into place by the laborers. Where the largest percentage of large stone possible is desired, I would suggest that the engineer state this fact, rather than a definite percentage. This percentage is of course a function of the kind of rock used by the contractor, and it is hard to stipulate on paper what the maximum possible amount wil be, before you have tried it.

CONCRETING.—Unreinforced concrete arches should be laid up in alternate transverse blocks (methods employed at the Big Muddy and Connecticut Ave. bridges) as the great weight of the concrete in this class of concrete work causes serious deformation of the center unless the latter be made very heavy. This deformation causes transverse cracks and small fissures if the arch be built up in continuous transverse blocks, and if built up in longitudinal rings the load of the second ring will have a tendency to strike the portion of the center under the first ring, and the third ring will have a tendency to strike the portion of the center under the second ring, etc. In addition to this there would result a warped soffit which might be offensive to the eye.

Reinforced arches, which as a rule bring a light load on the center, should be built up in longitudinal rings made to incorporate two or three of the steel rib reinforcements. By using this method the steel ribs are better encased and you are enabled to get the separate rings built as monolithic arches from skewback to skewback.

In jacketing steel beams and girders, the jacketing of a day's work should not be stopped at the level of the top of the top flange, because if this is done the concrete, which shrinks when it sets up, will not be snug against the under side of the beam or girder. This small space between flange and concrete can never be filled up. A day's work should be kept several inches below the top flange, or be carried up several inches above, so that the concrete will set up against the flange under a head.

Placing wet concrete in deep layers or breasts, as 2 ft., may be done not only in foundation work but also in heavy work above ground where there is to be a facing of ashlar (as commonly practiced by railways) or where the appearance of the face is not a matter of import.

In dumping concrete in narrow forms for thin walls and columns the contractor will find it advantageous to use a bucket with a narrow outlet controlled by sliding gates (Hains), so as to be able to dump the concrete into the forms in comparatively small quantities. A great many tie-rods are broken in dumping large quantities of a yard or more with the ordinary side or bottom-dump bucket, and many more tie-rods are bent, thereby distorting the forms. The type of bucket suggested is also a material advantage to the contractor because it diminishes the cost of spreading the concrete.

PROTECTION FROM FREEZING.—Concrete should be protected from the cold so that it will not freeze. It is believed that if concrete freezes only once, and then before setting up, it is not injured by this one freeze, but the time of set is retarded; the bond, however, of the concrete which has been frozen will not be as hard to the unfrozen layers as if it had not been frozen. Mortar facing which is once frozen is permanently injured, due possibly to the expansion which takes place during freezing. There are innumerable coverings for the top surface of concrete to prevent freezing. Canvas, cement bags, tar paper, straw, sand and manure are all used for this purpose. (The heating of materials has been previously referred to as one of the best guarantees that the concrete will not freeze.) Bear in mind in this connection that concrete generates heat when it sets up, therefore the problem of the engineer is somewhat simplified; my own observations lead me to believe that this generation of heat lasts for at least 30 days.

When canvas is used it should be kept an inch or two away from the concrete, leaving an air space between the concrete and canvas. If this is not practicable I would suggest two layers, if the thermometer is liable to fall to 20° F. Cement bags should be in layers and well lapped; if this is not done the concrete will be frozen between consecutive bags. Tar paper should be well lapped and used as suggested for canvas. Straw should be used at least 1 ft. deep, and, in extreme weather, deeper. In conjunction with tar paper and canvas, it works very well. Manure is the best of materials, as it is a heat generator, but it discolors the concrete (this is seldom of import). Stoves are also used for this purpose, but are going out of use. Steam pipe has been used over boxed areas, but is expensive. In extremely cold weather the laying of steam pipe on the surface of concrete is probably the very best way to protect it from freezing, in spite of the cost. These pipe-lines should be covered up with canvas or tar-paper so as to keep the heat in.

In narrow form work where the forms are three or four times as high above the concrete as the least horizontal dimension of the pit, little protection is required—particularly if the temperature of the concrete itself when placed is in the neighborhood of 50° F.—even if the thermometer fall as low as 20° F. (This refers to the top surface of the concrete—of course the vertical surfaces may be affected if not protected as described before in this article.)

CONCRETING IN WATER.—Don't place concrete in running water or still water if it is practicable to get rid of the water.

In still shallow water, deposit the concrete so as to back the water in one direction (of course all concrete placed in water, shallow or deep, should be placed in as large batches as practicable). In running water try to localize the flow in pipe or chutes or by use of bulkheads (bag concrete is good for this purpose), and if this is not practicable deposit the concrete as suggested in still water, working in one direction, backing the water to the low side.

Great care should be taken not to pump the water out of the pit while concreting, if this can be prevented. If you do, you are liable to lose your cement, leaving only the aggregate behind. By locating your pump a good distance from the point of concreting, you may get good results; but great care should be then used and the inspectors should keep their eyes on the water flowing from the pump. If you are losing cement you will, as a rule, be able to detect the fact by the appearance and odor of the water. I have heard recently of two piers whose settlement has been attributed to this oversight.

Concrete dumped under water should, of course, be dumped as close to the bottom as practicable. It is not necessary to ram it; a mixer walking over it does more harm, as a rule, than good by stirring up the cement, which rises to the surface.

I saw one piece of work where concrete was dumped at the surface of the water through 15 ft. of water, and I understand a good hard concrete was formed on the bottom. The concrete was dumped in two-yard batches and was quite wet. The amount of cement which rose to the surface was surprisingly small.

In repair work to masonry walls, to undermined foundations, particularly to river piers, bag concrete is an excellent material. In river work an ordinary cement bag, two-thirds filled with wet concrete, when laid up carefully by a diver, will give good results. This class of work will stand 10 or 12 tons per sq. ft. with a good factor of safety. Bag concrete can also be used on small work for foundations, in running water, where good economy would not warrant a cofferdam and pumping. It can also be used to divert a heavy stream of water (inside a cofferdam) and can afterwards be incorporated in the mass, that is, concreted in.

DECREASING THE PERMEABILITY.—Last year the grouting of a crack in a massive concrete wall suggested the feasibility of decreasing the permeability of porous concrete by drilling holes into the concrete and forcing grout into the concrete with grout pumps. In forcing grout into several holes we noted that it was forced out in small quantities at innumerable points, indicating that we were not only grouting the crack but also the concrete. The concrete was not a porous one.

ESTIMATING COST.

Contractors in making up their bids should bear in mind that there are all classes of concrete. Its cost varies between $3 and $45 per cu. yd., and it is up to the contractor to find out where each item of concrete stands between these figures.

The cost depends upon specifications, the customs of a community, the engineer in charge, the market, the demand for labor, kind of labor available, the hours of labor, the location of the work, the cost of materials, the storage room available in order to handle the construction, the haul and the kind of work, the time of year, the climatic conditions, including freshet conditions, and the time allowed to complete the work, including the penalties for failure to finish in the stipulated time. The kind of work is so varied—from foundation mass work requiring shoring and pumping to a highly detailed balustrade—that it is no wonder that unfortunate bids for concrete work occur so often. Every engineer in the concrete field is constantly meeting contractors who have failed in making up bids to consider the various classes of work covered by the bid.

Moreover, reinforced concrete is so new and the demand for this class of design is so great that engineers have not been able to spend as much time as they should in figuring out systems of reinforcement which would not so greatly increase the cost of placing the concrete. This cost varies between 15 cts. per cu. yd. for mass work to $10, and if you want to get cheap work you must get the concrete placed at a reasonable figure. It is only fair to say that a considerable part of the cost referred to is due in part to ornamentation, which goes with the most expensive reinforced work. Narrowness of forms, excessive detail and steel reinforcement are the items which run the cost of placing concrete to such an extraordinary figure.

year, and the fuel value of the combined waste ($3,130) to $3,900 a year. But, Mr. Floy states:

> The fuel value of the refuse having been credited to the operating charges of the destructor, the electric light station must be charged with the full value of the fuel it requires, whether that fuel be coal or city waste, [since] it would evidently be unfair to credit both the waste destructor and the electric plant with the fuel value of waste combustion.

Editorial discussion of some phases of the report will be found elsewhere in this issue.

COUNTERWEIGHT DEVICE ON THE BALMAIN TRAMWAY, SYDNEY, NEW SOUTH WALES.*

By PERCY WILLIAM SHAW,† M. Inst. C. E.

In 1902, the Government of New South Wales authorized the extension of the Balmain Tramway, Sydney, from Gladstone Park to the Darling Street wharf, ¾-mile distant, from which a line of ferry-boats maintains a regular service with the city. The extension, which is operated electrically, was constructed and opened for traffic as far as Nicholson St. in November of the same year. From this point the ground falls rapidly to the wharf, a distance of 10 chains, the first 3 chains of which are on a gradient of 1 in 10.54, while the remainder is on a decline of 1 in 8.24. Although in a few instances gradients as steep as 1 in 8 have been successfully introduced in electric lines depending on adhesion only, it was not deemed advisable, under the circumstances, to adopt this course. From experience gained on other lines of the system, with gradients as steep as 1 in 10 running up from the water's edge, the Railway Commissioners, who control the traffic on tramways as well as on railways in New South Wales, decided that it was not advisable to construct tramways on gradients steeper than 1 in 12, and this decision has been adhered to as closely as possible ever since by the Construction Branch.

In order to obtain this gradient from Nicholson St. to the wharf, several circuitous routes were considered, but owing to the excessive cost of the land required to carry them out they were finally abandoned, and it was decided to continue the line directly to the wharf on the steep gradient, and to assist the ascent and control the descent of the cars by means of a counterweight. The author received instructions to prepare a scheme on this principle in November, 1902. His scheme was approved, and authority for the construction of the works was obtained in February, 1903; the line was completed and opened for traffic in the following November.

The main object aimed at in the design of the counterweight device was to secure safety and ease in operation, while at the same time permitting any car in service on the Sydney Tramways to be used on the Darling St. section without any extra attachment or alteration. The counterweight was considered simply as a means of reducing the steep gradient to one which could be safely operated with any car and by any driver, so that it should not be necessary to employ only picked men. The results have proved entirely satisfactory, the line having now been in constant use, on a 20-minute service, for more than two years, during which time it has received some fairly rough handling from inexperienced and nervous drivers.

The general arrangement of the running-track and counterweight subway is illustrated in Fig. 1. The descending car, on coming on to the incline, is brought into contact with a buffer-trolley, which it carries along in front of it. The buffer-trolley is attached by a steel-wire cable, passed round a sheave at the top of the incline, to a counterweight trolley running on rails in a subway under the incline, so that as the car descends the counterweight trolley ascends, acting as a brake on the descending car. At the foot of the incline a buffer-stop prevents the car overreaching and carrying the counterweight too far up. On the return trip the car is started in the ordinary way by means of the electric motors, and the trolley, now at the rear end of the car, exerts a constant force upon it due to the pull of the descending counterweight, and thus assists the car up the hill. On arriving at the top the trolley comes to a stand-still by the counterweight arriving at the foot of the subway, where it is brought to rest by a hydraulic buffer in which the momentum of the moving weight is absorbed.

PERMANENT-WAY.—As the roadway is only 32 ft. in width between the curbs, the center line of the surface track was laid 2 ft. 6 ins. out of line with the existing track, so as to bring it 9 ft. from the curb and leave as much room as possible for vehicle traffic. The track consists of grooved rails weighing 83 lbs. to the yard, in 30-ft. lengths, resting on a bed of concrete 6 ins. in thickness. The rails are anchored down by means of two short lengths of T-rails, weighing 60 lbs. to the yard, bolted on to the bottom flanges 6 ft. from the end of each rail. The gage of 4 ft. 8½ ins. is maintained by tie rods bolted through the webs of the rails at every yoke. The cast-iron yokes, spaced 3 ft. 9 ins. apart, are bedded in concrete, and support the slot beams which are bolted on with two ¾-in. bolts on each side. The slot beams are in 15-ft. lengths, laid so as to break joint, and secured by two bolts at each end. Carrier sheaves, 12 ins. in diameter, fixed at intervals of 30 ft. in pockets below the level of the cable tube, support the cable at a height of 6 ins. above the bottom of the tube.

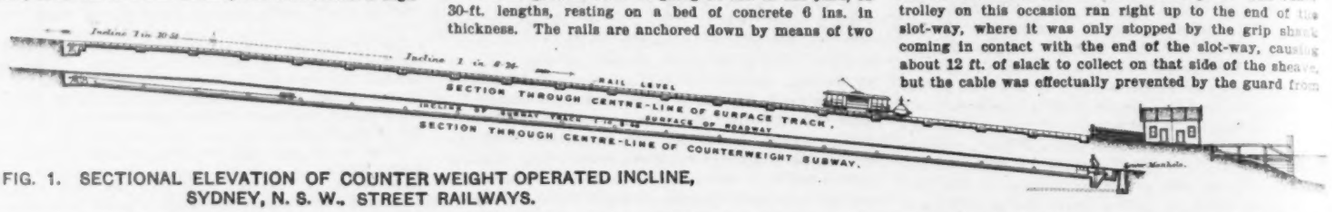

Incline 1 in 10.54
Incline 1 in 8.24.
RAIL LEVEL
SECTION THROUGH CENTRE-LINE OF SURFACE TRACK.
SURFACE OF ROADWAY
SECTION THROUGH CENTRE-LINE OF COUNTERWEIGHT SUBWAY.

FIG. 1. SECTIONAL ELEVATION OF COUNTERWEIGHT OPERATED INCLINE, SYDNEY, N. S. W., STREET RAILWAYS.

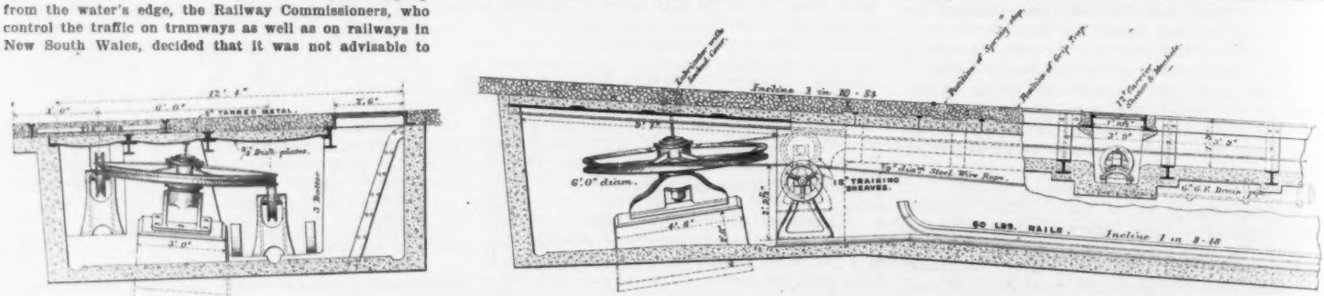


FIG. 2. LONGITUDINAL AND CROSS-SECTIONS OF SHEAVE PIT AT HEAD OF INCLINE.

SUBWAY.—In most inclines operated by means of a counterweight running in a subway, the subway has been constructed under the running track. In some cases the subway follows the contour of the line, and the rails are laid directly on the roof, without packing; but this method has not proved satisfactory, and much better results have been obtained where the subway has been laid on an even gradient, and at a sufficient depth to permit of the sleepers being ballasted and packed in the usual manner. Owing to the rocky nature of the ground through which the subway would have to be cut, and the small depth available for drainage at the foot of the incline, it was considered advisable to place the subway on one side, at a distance of 6 ft. from the surface track, c. to c., Fig. 3. The counterweight trolley track is of 4 ft. 6 ins. gage, and is laid on an even gradient of 1 in 8.48, at a minimum depth of 4 ft. 6 ins. below the level of the surface track. Carrier sheaves, similar to those in the surface track are set in the center of the track, spaced 30 ft. apart.

SHEAVE PIT.—At the top of the incline the cable connecting the buffer trolley with the counterweight passes round a sheave, 6 ft. in diameter, set in a pit below the surface of the road.

Before the line was handed over to the Railway Commissioners the author had a car at his disposal for the purpose of making a series of trials. On one occasion he had the car taken over the hill at full speed. The buffer trolley on this occasion ran right up to the end of the slot-way, where it was only stopped by the grip shank coming in contact with the end of the slot-way, causing about 12 ft. of slack to collect on that side of the sheave, but the cable was effectually prevented by the guard from coming off the sheave. To prevent the trolley from traveling too far in the future, a spring stop was fixed, about 3 ft. from the end of the slot-way, under the slot-beams, and bolted to them. The stop is made and fixed so that its rod meets the grip shank as close to the slot-beams as possible. Cast-iron training sheaves, 15 ins. in diameter, are set on each side to lead the cable on to the 6-ft. sheave; these are also provided with a hoop-guard, to prevent the cable from being jerked off in the event of any slack being formed by unevenness in the tension of the cable. The 6-ft. sheave is fed with oil through a small brass tube from a lubricator fixed above it, encased in a cast-iron box attached to the upper side of the roof plates, and having its cover flush with the roadway. This cover is provided with a locking arrangement so adjusted that the key cannot be withdrawn in any other but the locked position, in order to preserve it from being tampered with by unauthorized persons.

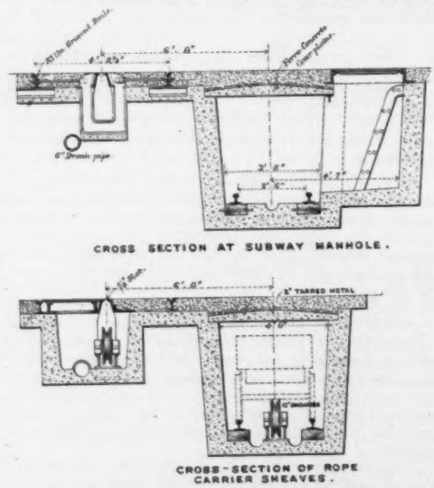


Fig. 3. Cross-Sections of Incline at Subway Manhole and at Rope-Carrier Sheaves.

TERMINAL PIT.—At the end of the incline and close to the wharf a terminal pit is constructed for the accommodation of the hydraulic buffer and counterweight trolley. The pit, 23 ft. 6 ins. in length, is provided throughout its entire length with a removable roof covering, composed of reinforced concrete plates, supported on rolled joist bearers and columns, set in line with the subway. Passages 2 ft. in width run along each side of the pit, covered with a fixed roof composed of ⅜-in. dish plates, attached to the rolled joists and angle-bars, and filled with concrete. On one side this roof covering supports one rail of the surface track, which terminates near its center in a fixed buffer stop. After the roof dish plates had been bolted in position, and the buffer stop had been erected and fixed a concrete buttress 3 ft. in length was built up from the floor to the underside of the roof to transmit the thrust on the buffer stop directly to the solid ground and thus prevent straining of the roof.

BUFFER TROLLEY.—Running on the surface track is a small buffer trolley connected by a steel cable to the counterweight. The steel cable running in the cable tube is permanently attached to a grip by means of a 1⅝-in. connecting pin and shackle, with a 1¼-in. square shank bolted through the grip plate. The grip plate is held against the lower end bearing by a helical spring on the shaft, interposed between the plate and the upper bearing. The spring, which is made of ¾-in. square steel, and has a mean diameter of 3½ ins. and a length of 8⅜ ins., takes up any undue strain that may be put on the cable. The grip plate is also free to swing sideways, and to adjust itself in the slot-way. The upper or after end of the trolley has an ironbark timber buffer, 1 ft.

*From the "Proceedings of the Institution of Civil Engineers."

†Tramway Construction Department, Sydney, N. S. W.

9 ins. in length, attached to two buffer rods and volute springs working in cast-iron boxes, spaced 6 ins. on each side of the center line. The front face of the buffer beam is hollowed out in the center, to ensure the curved buffer plate on the cars striking the beam on each side of the center, and as nearly as possible in line with the buffer rods. The beam is given ample depth to allow for the variation in height of the car buffers, amounting to about 3 ins. The lower or front end of the trolley has two ordinary side buffers, with volute springs, spaced 4 ft. 9 ins. apart. The weight of the cable as it sags between the carrier sheaves in the subway lifts the trolley about 5 ft. farther up the incline after the counterweight has been brought to rest, and the process of gathering up this slack is so gradual that the trolley sustains very little shock from its sudden contact with the descending car, and is carried smoothly forward without apparently offering any resistance. As a precaution against accidents, the trolley is surrounded by a guard suspended from the body and reaching to within 3½ ins. of rail level. The front end is formed into a cow-catcher, while the rear end is hung on hinges, forming a gate and giving access to the interior.

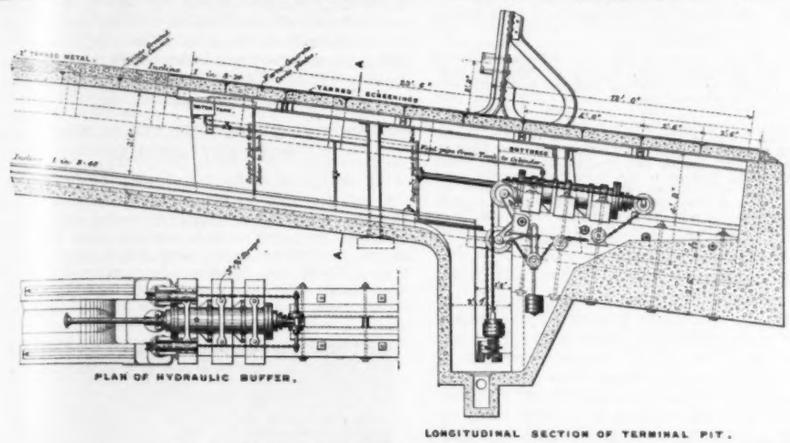


FIG. 4. PLAN AND LONGITUDINAL AND CROSS-SECTIONS OF TERMINAL PIT, SHOWING HYDRAULIC BUFFER.

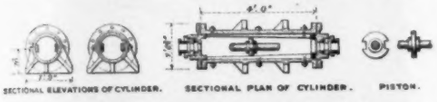


Fig. 5. Details of Cylinder and Piston of Hydraulic Buffer.

COUNTERWEIGHT TROLLEY.—As already mentioned, the object of the counterweight was to reduce the steep incline to the equivalent of a safe and workable gradient. With this end in view, the weight to be attached was not required to balance the cars, but merely to offer sufficient resistance to enable them to be safely controlled by their own brakes in descending the incline, and to offer some assistance in ascending. The cars running on this line are mostly of the bogie combination type, 37 ft. 6 ins. in length over the headstocks, with a 12-ft. box compartment in the center, and open ends, each containing two longitudinal seats and one cross seat. They have seating accommodation for 42 persons, and weigh, on an average, 15 tons loaded. The counterweight trolley complete weighs 11 tons, and runs on a gradient of 1 in 8.48, or 11.79%. Taking 22.4 lbs. per ton per 1% of gradient for the gradient resistance, and 10 lbs. per ton for rolling friction, the total resistance of the weighted trolley is $\frac{(11.79 \times 22.4) + 10}{2,240} \times 11 = 1.34$ ton. This represents the tension on the cable due to the trolley, but its effectiveness is diminished by the resistance due to the weight of the buffer trolley running on a gradient of 1 in 8.24, or 12.13%. The weight of the buffer trolley is 1.35 ton, and with the same allowances for gradient resistance and rolling friction the total resistance in this case is 0.17 ton, which, deducted from the counterweight's resistance, gives an effective resistance of 1.17 ton. The total resistance of a car weighing 15 tons on a 12.13% gradient, using similar data, amounts to 1.88 ton. In descending the incline, the friction of the rope and sheaves acts against the car, and assists the action of the counterweight; but in ascending, the counterweight has to overcome this friction, which acts against it. Allowing 10% for rope friction, the effective resistance offered by the counterweight to the descending car would be 1.17 + 0.11 = 1.28 ton, and to the ascending car, 1.17 — 0.11 = 1.06 ton. Taking the differences between these resistances and that due to the car, viz., 1.88 — 1.28 = 0.6 ton, and 1.88 — 1.06 = 0.82 ton, which are the resistances to be overcome by the car in descending and ascending, respectively, and converting these into their equivalent gradients, the following are obtained:

Effective descending gradient:

$$= \frac{\frac{0.6 \times 2,240}{15} - 10}{22.4} = 3.54\%, \text{ or 1 in } 28.25.$$

Effective ascending gradient:

$$= \frac{\frac{0.82 \times 2,240}{15} - 10}{22.4} = 5.02\%, \text{ or 1 in } 19.92.$$

It will be readily seen that these effective gradients are only approximate, owing to the varying weights of the cars and the varying effect of the cable according to the relative position of the trolleys.

The underframe of the counterweight trolley is built of channel bars. Two intermediate channels, fixed 2 ft. 9½ ins. from the headstocks, divide the body into three compartments. The two end compartments are strutted with wrought-iron stays, meeting near the center of the intermediate channels. A 1½-in. shackle bolt is provided at one end, for the attachment of the cable, working in a 1¾-in. wrought-iron pipe with screwed flanges bolted to the inside of the headstock, and to the intermediate channel. The shackle bolt projects into the center compartment, and is there secured by a nut and washer, screwed against a helical spring. The other end of the underframe is fitted with an ironbark timber buffer beam bolted to the headstock. The face of the beam is cut to a curve, so that it has a thickness of 6 ins. at the center and 3 ins. at the ends; a copper plate is bolted on at the center and dished to suit the rounded end of the hydraulic buffer. The two end compartments are covered on the underside with ⅛-in. wrought-iron plates riveted to the frame, and are filled up with lead, run in hot, to within ½-in. of the top of the framing.

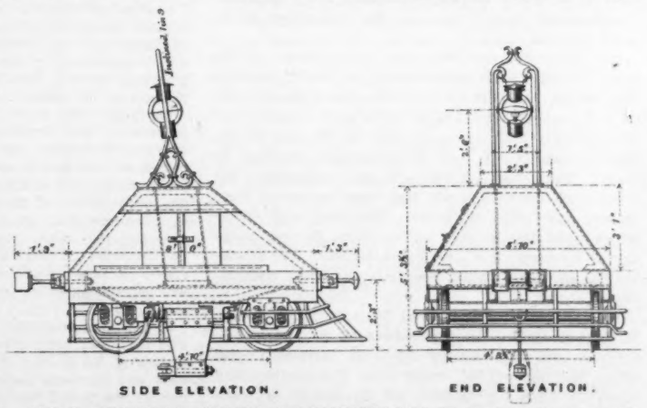


FIG. 6. BUFFER-TROLLEY (OR "BARNEY," AS IT IS CALLED IN THE U. S. A.) RUNNING AHEAD OF CAR ON INCLINE.

STEEL CABLE.—The cable operating the counterweight is of galvanized crucible steel, ⅞-in. in diameter, and is composed of six strands, each consisting of twelve wires 0.071-in. in diameter having a breaking stress of 80 tons per sq. in., and a hemp core. The cable weighs 1.1 lbs. per ft., and is guaranteed to withstand a stress of 23 tons without breaking, while the working stress is roughly about 1.5 ton. The cable is coated with a preservative composition to exclude moisture.

HYDRAULIC BUFFER.—Hydraulic buffers have been in use in terminal railway stations since about 1884, when they were first introduced at Liverpool St. and Fenchurch St. Stations. They formed the subject of a paper by Mr. A. A. Langley, read before the Institution of Mechanical Engineers in 1886. The hydraulic buffer adopted on the line under description has a stroke of 3 ft. 6 ins., and is similar to those described by Mr. Langley; it is illustrated in Figs. 4 and 7, Plate 1. The cylinder is of cast-iron and is 10 ins. in diameter and 4 ft. in length. The metal of the cylinder is 1½-in. in thickness for about three-quarters of its length from the front face, the thickness being increased to 1¾-in. for the last quarter. A rectangular parallel wrought-iron feather, turned on one side to fit the cylinder, is bolted on each side of the cylinder inside. The feathers are 3 ins. in width by 1½ ins. in thickness at the back end, tapering to ½-in. in thickness at the front end and running from cover to cover. The covers are each provided with two screwed glands; the inside gland, of cast iron, holds the hat-leathers in position, while the outer one, of brass, is packed with gasket packing. The hat-leathers have proved very effective in keeping the cylinder tight, with very little friction, and have worn well, the original pair being still in good order after two years of constant service. The packed glands are run slack, being intended only as a stand-by in the event of the hat-leathers being blown out or otherwise failing. The piston is a plain disk of cast iron, $9^{23}/_{64}$ ins. in diameter, having rectangular waterways 3 ins. in width by 1½ ins. in depth cut longitudinally on each side to work along the feathers in the cylinder. A rubber pad, 1½ ins. in thickness, bored out to clear the collar nut on the piston, is inserted at the bottom end of the cylinder as a final cushion. The clearance between the piston and the cylinder is equal to an area of 0.25-sq. in., and the full waterways have an area of 6 sq. ins. As the piston advances, the waterways are gradually diminished by the tapering feathers, causing gradual increase in the pressure behind the piston, which finally brings it to rest.

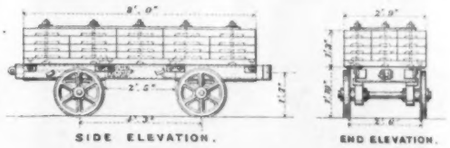


Fig. 7. Side and End Elevations of Counterweight Car.

To bring the buffer forward again, after being pushed in by the counterweight, cast-iron weights are attached to a cross-head on the tail-rod of the piston by means of chains running over pulleys at the front end. The crosshead is provided with a pair of wheels running on a timber guideway faced with angle bars. The weights are in three sets, attached to the ends and center of the crosshead, respectively. The center weight is divided into a main weight and a jockey-weight, the latter being suspended from a 6-in. pulley running in guides which

rides on the center chain. The main weight comes to rest on cross timbers in the well, placed so that the jockey-weight is supported on the slack of the chain when the buffer is in the forward position. The jockey-weight is lifted by the chain before the main weight, and thus acts as a spring in taking up the first shock on the chain.

The hydraulic cylinder is automatically fed with water by gravitation from a small tank fixed at the top end of the terminal pit, and a brass non-return ball valve is fitted on the pipe close to the cylinder. A small valve attached to the top end of the cylinder is provided for the escape of air which accumulates inside the cylinder, and which should be regularly released to prevent it from collecting and displacing the water to an extent that might prove disastrous. The consumption of water has been very small, owing to the excellent working of the hat-leathers, the meter not having yet registered 100 gallons.

The speed of the cars on the incline is usually not more than 5 or 6 miles per hour, and as a precaution against the cars being driven too fast over the top of the hill, where they leave the buffer trolley, and where the reduced gradient tends to accelerate their speed, Nicholson St. is made a regular stopping place. The cars stop while still in contact with the trolley, and the counterweight, having only a few feet to travel when the car is started

William J. Oliver.

again, does not get up an appreciable speed before it is brought to rest by the hydraulic buffer.

TESTING.—The cylinder of the hydraulic buffer satisfactorily stood a test pressure of 1,600 lbs. per sq. in. in the shops, with its covers on, and the piston rod in position. Before the cover plates were put on the terminal pit, the counterweight was hauled up the incline to distances representing speeds of 1 to 12 miles per hour at the moment of impact with the hydraulic buffer. The trolley was released from the hauling tackle by means of a trigger and was allowed to run freely in order to attain the required speeds.

With speeds up to about 4 miles per hour the rod seemed to be driven in without appreciable resistance, coming quietly to rest at the finish; but as the speeds increased the resistance became more noticeable. At the higher speeds the rod in every instance came to a dead slow about 9 ins. from the end of its stroke, and then traveled quietly to the end, but on no occasion could any motion be detected in the cylinder or bed timbers. At 10 miles per hour the sudden jar caused the side weight chains to jump off their pulleys; and to prevent this a wrought-iron hood-guard was bolted over each pulley, after which they gave no more trouble even at the higher speeds. The jockey-weight on the center chain proved very successful, the main weight rising in every instance without any apparent jerk.

The line was constructed by the Department with day labor; the high rate of wages, and the minimum rate of 7s. per day for all labor in vogue at the time, brought the cost of the work up to a total of £5,606, including a contract let to the Clyde Engineering Co. for the manufacture of the hydraulic buffer, counterweight and buffer trolleys, for £448.

The work was carried out under the direction of Mr. H. Deane, M. A., M. Inst. C. E., Engineer-in-Chief for Railway Construction, with the author as Supervising Engineer for Tramway Construction, Mr. Thomas Rhodes being the Assistant Engineer on the works.

THE LOWEST BIDDERS FOR THE PANAMA CANAL CONTRACT.

We printed last week the bids opened on Jan. 12 for completing the Panama Canal. As there noted, the lowest bidder was the Oliver-Bangs combination, their bid being 6.75% on the cost of the work. On Jan. 17 the following information regarding the award of the contract was given out by the Commission:

Chairman Shonts announced that at a conference between the President, Secretary Root, Secretary Taft, and himself, with respect to the pending contract for constructing the Canal, it was decided, first, that the lowest bid received, that is, 6.75%, was a percentage at which the government would be justified in placing the contract.

The second point in the determination of this matter is whether or not the persons making the bid, that is, Messrs. Oliver and Bangs, can qualify financially under the requirements, that is to say, whether they can show that they have, or can control, $5,000,000 available for this work; that is $5,000,000 above liabilities, including the $2,000,000 which will be required to make the bond.

It was further decided that if their personal records and business standing are found, after investigation, to be all right, they ought to have the contract.

It is stated that Mr. Oliver holds a two-third's interest and Mr. Bangs one-third interest in the combined bid. Mr. Oliver is probably the largest employer in the country of negro labor. He plans to utilize Southern negroes for a large part of the work at Panama. A scheme has been worked out by which entire contract gangs will alternate between work in the South and work at Panama. It is well known that men from the North cannot go to a tropical climate and work continuously at the same rate as in the temperate zone, and that occasional furloughs at the North are necessary to preserve the health of white men working in the tropics. Mr. Oliver, therefore, is said to be planning to give the benefit of similar changes of climate to the entire force of Southern negroes which he may employ there.

We give herewith portraits from recent photographs of Messrs. Oliver and Bangs. Mr. Wm. J. Oliver, although he has been for 20 years a resident of and identified with the South, was born in Mishawaka, Ind. He is a nephew of Jas. Oliver, the founder of the Oliver chilled plow industry. Wm. J. Oliver's father, although at one time wealthy, suffered financial reverses and the son had to earn his own living from an early age. At the age of 16 he was a time keeper on railway work and five years later, on attaining his majority, he started in business for himself with a 15-team outfit as a contractor on the Cotton Belt R. R. His rise from that time has been steady and rapid and he has played a prominent part in the development of the new industrial South which has taken the place of the agricultural South of a generation ago.

We gave last week a list of the contract work now in Mr. Oliver's charge, but did not include two very important pieces of construction. These are the construction of a reinforced concrete dam and water power plant across the Tennessee River below Chattanooga, Tenn., the estimated cost of which is $3,000,000, and a large plant at Cumberland Gap, Tenn., for the Tennessee Portland Cement Co.

Mr. Oliver is president and sole owner of the Wm. J. Oliver Manufacturing Co., at Knoxville, Pa., which has a large plant for the manufacture of contractors' cars, mine cars and contractors' machinery. He owns a controlling interest in the James Supply Co., of Chattanooga, dealers in heavy machinery, hardware and supplies. He owns and operates grain elevators in Indian Territory, saw mills in Indian Territory and Oklahoma; has the largest kaolin mine in the country at Langley, S. C., and is a director and stockholder in three large Southern banking institutions.

Mr. Anson M. Bangs was born at Fayetteville, N. Y., in 1860. He was educated at the public schools and at Phillips Andover Academy and after leaving school went into the contracting business with his father, Eli T. Bangs, a well-known government contractor.

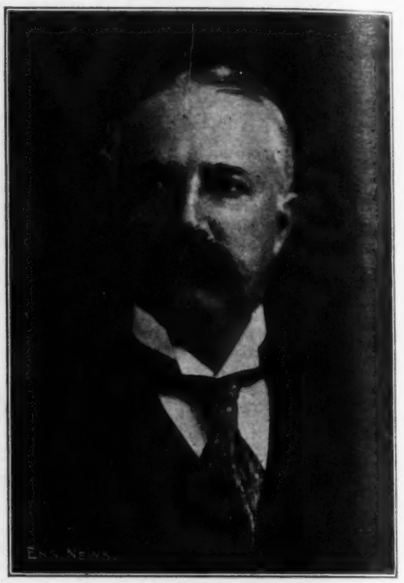
The manufacture of cement and the stone quarrying business is an industry in which the Bangs family has been engaged for several generations. The cement which went into the Albany State House was largely made at the Fayetteville works. It is a singular fact that when Mr. Bangs built the great Poe lock at Sault Ste. Marie he had occasion to tear down some old masonry laid with cement made by his grandfather at Fayetteville in 1850. This grandfather, Capt. R. H. Bangs, of Revolutionary fame, was also a contractor.

An account of Mr. Bangs' successful contracts as a member of the old firm of Hughes Brothers & Bangs was given in our last issue. Mr. Bangs is president of the Federal Contracting Co. and vice-president of the New Jersey Terminal Dock and Improvement Co. His offices are at No. 5 Nassau St., New York City.

THE RELATION OF THE INSPECTOR OF PLUMBING TO OTHER CITY OFFICIALS.*

By CHAS. B. BALL,† M. Am. Soc. C. E.

In the discussion of this topic, consideration will be given to some of the points of contact between the Plumbing Bureau of a large city and seven other Municipal Departments, viz.: Law, Police, Street, Sewer, Water, Health and Building. In view of the inquiry lately raised as to which of the two latter departments should have authority over plumbing inspection, some



Anson M. Bangs.

attention will be devoted to the arguments advanced for each type of administrative control, and a tabulated statement will be presented showing the jurisdiction over Plumbing Bureaus in some of the largest cities of the United States.

THE RELATION OF THE INSPECTOR OF PLUMBING TO THE LAW DEPARTMENT.

Cooperation with the Corporation Counsel or other legal officials of the city will arise mainly through two classes of conditions: (1) When ordinances affecting plumbing are being framed or are under revision; (2) when the plumbing office is called to furnish information for the prosecution of violators.

The prime duty of the inspector in respect to any new provision or any proposed amendment must be to apply to such requirement the test of reasonableness. Is the provision such that it can be defended in the courts as a reasonable and fair and just requirement? He must not be surprised if the city's lawyers are not always in full accord with his views on this point. If they are not, and fail, with their predilection in his favor, to be converted to his conclusions, there is not much reason to believe that property owners, judges and juries will be convinced that the regulation which he advocates is reasonable.

At the same time, the inspector must not fail to recognize that laws and regulations through which the police powers of the State and city are exercised should keep pace with advanced public opinion on all matters which involve the public health and safety.

An important part of the duties of the chief inspector must be the preparation of cases for prosecution where ordinances have been violated. This work should receive his personal attention as far as circumstances permit. The thoroughness and care with which evidence

*A paper, slightly abridged, read before the American Society of Inspectors of Plumbing and Sanitary Engineers, at Cleveland, O., Jan. 8, 1907.

†118 Hazel Ave., Chicago, Ill.

is secured and the ability of the inspector to point out with definiteness in each case the provision of the regulation which has been violated, will aid greatly in stimulating efficient work on the part of the prosecuting attorney. It will also produce a salutary effect upon violators of the law if the inspector has a clear and definite knowledge of violations upon which an action can be based. The inspector must not, however, expect to find that the construction of the regulations as to their intention is as plain to the legal authorities as it may be in his own mind. The method of the lawyer in construing statutes is so much more exact than is that of the inspector, and the mind of the latter so occupied with the technical features of the subject, that frequent differences will occur in this regard.

Advance consultation with the city solicitor in obtaining his construction of the most frequently violated parts of an ordinance will lead to the avoidance of labor in prosecuting cases which lie near the line of violation, but which under a somewhat liberal construction of the law may not necessarily be included within it.

THE RELATION OF THE INSPECTOR OF PLUMBING TO THE POLICE DEPARTMENT.

Cordial good feeling between police officials and the Plumbing Bureau is requisite in order to secure the apprehension of offenders, especially in cases where plumbing work is being done by unlicensed plumbers or without the permits which are required to be issued by the Plumbing Office. The active support of the police may also be needed to enforce the right of entrance into premises where it is desired to make an investigation, and to which admittance is denied. Cooperation may here also be facilitated by conferences with the administrative officials of the Police Department, in which the inspector of plumbing may suggest those particulars in which the plumbing ordinance is most likely to be infringed in such a manner as to make action by the police necessary, as well as the kinds of persons whom he thinks most likely to offend, and the localities in which violations are to be anticipated.

THE RELATION OF THE INSPECTOR OF PLUMBING TO THE STREET DEPARTMENT.

The inspector of plumbing will come in touch with the Street Department mainly in connection with the work performed by plumbers in opening trenches in the public streets for the introduction of sewer and water supplies. In some jurisdictions the inspector has little to do with such matters, but in the smaller cities he may have quite full control of the operations of the plumber in cutting pavements and in excavating and refilling trenches. In any case, there is no reason why a complete understanding should not exist between the inspector and the officials who may be charged with these duties, and yet it often happens that conflict results because of a lack of cooperation.

THE RELATION OF THE INSPECTOR OF PLUMBING TO THE SEWER DEPARTMENT.

In this respect, as in the inspector's relations with the Street Department, there is a widely varying practice between that of the specialized engineering organizations of the large cities and that of the small cities, having fewer officials, whose duties comprise more lines of work. The relation will also depend on the extent to which the laying of the house sewer, from the public main to its entrance into the building, is performed by the plumber. Where this work is done by city officials, the inspector of plumbing will usually have little direct connection with it. He should, however, so far as may be readily practicable, observe the character of such constructions, and if the sewer lines are not laid with suitable material in a proper way, report the facts to the officials in charge. If the house sewers are laid by the plumbers, their supervision should be under the Plumbing Bureau rather than under the Sewer Department, although it is desirable that the actual cutting of the main sewer walls for the connection of the house line should be performed by sewer employees.

The attitude of the inspector in relation to the necessity for extensions of the sewer system will greatly affect the progress of these improvements. It is surprising to discover in the built-up portions of the oldest cities an occasional block frontage not yet provided with public sewer service. Where an instance of this lack of these facilities is disclosed, the inspector ought to be persistent in his request that a service sewer be constructed. His active interest in forwarding the matter will often produce a result which the Sewer Department unaided cannot achieve.

THE RELATION OF THE INSPECTOR OF PLUMBING TO THE HEALTH AND BUILDING DEPARTMENTS.

Some discussion has arisen during the past few months respecting the question of proper jurisdiction over the Plumbing Bureaus of large cities. It has been claimed that because plumbing depends upon a basis of sanitary science and is essentially a sanitary art, that therefore the supervision over its construction and repair should rest wholly with the Department of Health.

On the other hand, it is argued that the materials used, the design and erection of the piping systems employed, and the location of the various appurtenances within buildings comprise constructive features which are common to a number of lines of engineering work, so that the control of plumbing should logically be placed under the Building Department, because that department is charged with the supervision of similar kinds of construction pertaining to buildings.

There is an element of truth in each of these statements. It was undoubtedly best, in the early days of plumbing development, when the reasons for restrictive control were not generally understood, that the necessity for a rigid supervision by the authorities should be demonstrated by the health officials. At the present day, when the reasonableness of control is rarely questioned, and plumbing systems have become complex in design, an altogether different condition prevails, which, in my opinion, adds strength to the argument for placing the jurisdiction with the Building Department.

Emphasis must be placed upon the truth, not at first apparent to the casual reasoner, that the condition of plumbing in new buildings is in the end more vital to the public health than is the maintenance and repair of old plumbing. We need only to point out that the life and consequent danger from defective existing plumbing is limited to a few years at most, while the danger present from questionable design and faulty construction of plumbing in houses now being put up will be felt over a long period of years.

After some years of observation of Plumbing Bureaus under each type of control, it appears to me that the part of sanitary construction which has to do only with new work is better performed if its supervision is under a Building Bureau. It must in fairness be admitted, however, that in such case there is an inclination to neglect the inspection and repair of plumbing in existing buildings.

If, on the other hand, the supervision of plumbing is placed altogether with the Department of Health, it is quite likely to emphasize inspection and repair of old plumbing and be less subject to progress in design for new constructions.

Let us note the actual practice in some large cities as tabulated below.

An examination of the data here set forth shows that in four large cities, St. Louis, New Orleans, Washington and Milwaukee, the Plumbing Bureau exists as a division of the Board of Public Works, or its equivalent, and exercises its functions in a more or less independent manner. This arrangement has worked well in Washington and is desirable for all large cities. It will in most of them be impossible, because of legal and historical objections, rather than functional ones. In respect to New Orleans, the plan of organization is very recent and is not yet fully worked out.

Of the remaining 14 cities, nine Plumbing Bureaus are connected with the Board of Health, though doubtless in some instances this results in little more than a nominal control.

The other cities on the list, including New York, Boston, Cincinnati, Cleveland and Omaha, have intentionally chosen to develop the Plumbing Office as a division or adjunct of the Department of Buildings. The Ohio statute was amended last year, and under its operation the inspection of new plumbing in the cities of Cincinnati, Cleveland and Columbus will be with the Department of Buildings.

JURISDICTION OVER PLUMBING BUREAUS IN 18 LARGE CITIES OF THE UNITED STATES.

City.	Under control of the	Date of establishment.
New York	Bureau of Buildings	Created 1881. Transferred from Health Dept. 1893.
Chicago	Commissioner of Health	Created May 30, 1881.
Philadelphia	Bureau of Health	
St. Louis	Board of Public Improvements	
Boston	Building Commissioner	
Baltimore	Department of Health	Transfer considered 1906.
San Francisco	Board of Health	
Cincinnati	Building Inspector	Established 1888.
Cleveland	Building Inspector	
Buffalo	Department of Health	Established Jan. 1, 1892.
New Orleans	Sewerage and Water Board	Created Sept. 13, 1906.
Pittsburg	Board of Health	
Washington	Engineer Department	Created Aug. 1, 1881, under H. Dept. Transferred to Engr. Dept., 1883.
Detroit	Board of Health	Created 1895.
Milwaukee	Board of Public Works	Established Jan. 1, 1886.
Newark	Board of Health	
Jersey City	Board of Health	
Louisville	Board of Public Safety	
Omaha	Building Inspector	Created Jan. 1, 1890.

The situation in Baltimore has been the subject of much controversy, and is claimed by the plumbers to have been settled in favor of retaining the old method under the Health Department. Some of the reasons urged for doing this are local and temporary ones, such as the provision of the State laws which govern the matter, and the congestion of work in the Building Department. The Buildings Law Commission with the assistance of the inspector of buildings drafted and defended code provisions which would transfer the work to the Department of Buildings, but as I have been unable to learn the form in which these were presented, I cannot discuss them.

The tendency to depart from the historical traditions of origin and to place plumbing control with other building inspection seems to me inevitable. Do not understand that I advocate this change as immediately necessary. On the contrary I feel sure that it will come only through the gradual working out of underlying principles which tend to unify municipal administration.

The inspector of plumbing, in whichever of these relations he is placed, must keep himself in sympathy with the purpose of the other department. If in the Health Department, he should strive for the point of view of the building inspector in regard to constructive detail; if under the Department of Buildings, he should realize the importance of the maintenance and repair of existing plumbing.

Only through openness of mind toward the developments of the future and cordial cooperation with all present agencies for increasing his usefulness can the inspector of plumbing hope to achieve full effectiveness in the work given to his hand and brain.

A CODE OF ETHICS FOR ARCHITECTS.*

Section. 1. No member should enter into partnership, in any form or degree, with any builder, contractor, or manufacturer.

Sec. 2. A member having any ownership in any building material, device, or invention, proposed to be used on work for which he is architect, should inform his employer of the fact of such ownership.

Sec. 3. No member should be a party to a building contract except as "owner."

Sec. 4. No member should guarantee an estimate or contract by personal bond.

Sec. 5. It is unprofessional to offer drawings or other services on approval (and without adequate pecuniary compensation.)

Sec. 6. It is unprofessional to advertise in any other way than by a notice giving name, address, profession, and office hours, and special branch (if such) of practice.

Sec. 7. It is unprofessional to make alterations of a building designed by another architect, within ten years of its completion, without ascertaining that the owner refuses to employ the original designer, or, in event of the property having changed hands, without due notice to the said designer.

Sec. 8. It is unprofessional to attempt to supplant an architect after definite steps have been taken towards his employment.

Sec. 9. It is unprofessional for a member to criticise in the public prints the professional conduct or work of another architect, except over his own name or under the authority of a professional journal.

Sec. 10. Unpaid competitive work, either private or public, is detrimental to the architectural profession. Competitions should be held only under competent professional advice. Before accepting an invitation to compete, architects should agree upon conditions acceptable to all concerned, as prior acceptance may prevent just and desirable modifications.

Sec. 11. No member should submit drawings except as an original contributor in any duly instituted competition, or to secure any work for which such a competition remains undecided.

Sec. 12. The A. I. A. "schedule of charges" represents minimum rates for full, faithful, and competent service. It is the duty of every architect to charge higher rates whenever the demand for his services will justify the increase rather than to accept work to which he cannot give proper personal attention.

Sec. 13. No member shall compete in amount of commission or offer to work for less than another, in order to secure the work.

Sec. 14. It is unprofesional to enter into competition with or to consult with an architect who has been dishonorably expelled from the "Institute" or "Society."

Sec. 15. The assumption of the title of "Architect" should be held to mean that the bearer has the professional knowledge and natural ability needed for the proper invention, illustration, and supervision of all building operations which he may undertake.

Sec. 16. A member should so conduct his practice as to forward the cause of professional education and render all possible help to juniors, draftsmen, and students.

*Adopted and recommended to its members by the Boston Chapter of the American Institute of Architects.

THE PRESIDENTS OF FOUR NATIONAL ENGINEERING SOCIETIES.

(With inset sheet of portraits.)

For the twelfth consecutive year, we present to our readers portraits of the Presidents of the four great American engineering societies, and print below a record of the professional career of each.

George H. Benzenberg: President of the American Society of Civil Engineers.

By DON. J. WHITTEMORE,* Past-President Am. Soc. C. E.

George H. Benzenberg was born in New York City on May 31, 1847. The following year his parents moved to Detroit, Mich., and he received his primary education in the public schools and academy of that city. In 1863 he entered the University of Michigan, where he had the benefit of tuition under that eminent instructor, Prof. De Volson Wood, and four years later graduated in the Civil Engineering Course. At the end of his second year at college he was appointed Recorder on the U. S. Lake Survey, and at the end of the third and fourth years he was reappointed and served as assistant on the primary triangulation work of the Great Lakes.

Believing there was a better opportunity for the engineer in railroad work than in the Government service, he changed his field of work, and in 1869 served as transitman on the location, west of Charles City, of the Iowa division of the Chicago, Milwaukee and St. Paul Railway. The following year he designed and constructed the iron ore shipping docks at Milwaukee for the Bay View Iron Works, as well as the track system of this extensive plant, which now forms a part of the plant of the Illinois Steel Co. In 1871 he was in charge of the location of a large part of the Milwaukee & Northern R. R., particularly through the rougher country, and later was in charge of construction of this line, which was completed as far as Green Bay when the financial crash in the fall of 1873 practically put an end to all railroad work.

In the following spring he was appointed Assistant City Engineer of Milwaukee, Wis., in which position he continued for eight years, until February, 1882, when upon the death of Moses Lane, M. Am. Soc. C. E., he succeeded him as City Engineer. This office Mr. Benzenberg held continuously for over seventeen years. He was reelected year after year without solicitation or opposition, and during all that time but one single vote was ever cast against him in the City Council.

This position carried with it, beside the usual duties of a City Engineer, the entire management of the Water Department and its improvements and extensions, and also the office and duties of President of the Board of Public Works.

Mr. Benzenberg immediately began to develop the municipal work of Milwaukee on broader and more permanent lines, foreseeing the rapid growth of the city in wealth and population. Street pavements of a more permanent character were introduced; iron bridges were substituted for the numerous wooden structures; extensive viaducts were thrown across the valleys, and some of the first bascule bridges were erected. Relief sewers were projected and built to stop the frequent flooding of the low lying business districts; and all public squares and grounds were improved and developed into parks. Of course these radical and costly improvements aroused great opposition; but Mr. Benzenberg always succeeded finally in winning public approval for the plans of municipal improvement which he projected.

A notable illustration of his ability to win public consent to radical innovations was the introduction at an early date of water meters, installed at the consumer's expense. These were introduced almost universally on service pipes throughout the city; and the great resulting benefit to the water consumers and the city taxpayers has fully justified his action in recommending the innovation.

Among other notable achievements of Mr. Benzenberg in the Milwaukee Water Department were the city's new high service pumping station, which has served as a model for other pumping stations, and the first high-duty triple-expansion pumbing engine, which was built under his specifications. The new water-works tunnel and intake with its two large submerged intake cribs, located in over 50 ft. depth of water, and its two lines of 60 in. diameter cast iron pipe lines buried under the lake bottom was also designed and constructed by him. When the contractors were unable to complete the tunnel on account of encountering a subterranean stream and a bed of large boulders, he assumed personal charge of the work and he succeeded in carrying the work to a final successful completion notwithstanding the extraordinary difficulties encountered.

The sewer system of Milwaukee was redesigned on more comprehensive lines with a view of providing for future expansion of the city and also of maintaining the Milwaukee River above the new dam in a condition free from pollution and suitable for boating and bathing. In connection with the intercepting sewers he installed the first large centrifugal pump which is and has been in continuous operation, without a reserve, for the past 21 years.

In the face of strenuous opposition on the part of nearly every newspaper, of all organizations and of most of the population, he designed and completed the construction of the Milwaukee River flushing tunnel, whereby the river is supplied with from 420 to 450 million gallons of cold lake water each day, restoring the river to a very clear condition, notwithstanding the fact that the sewage and the factory wastes of over one-third of the city is being discharged into this stream. The screw propeller pump which he installed to handle this volume of water is claimed to be of larger capacity than any other single pump in existence.

During Mr. Benzenberg's long service as City Engineer he never permitted the discharge for political reasons of a single employee in any of the various departments of which he had charge, nor allowed any political interference in the conduct of the city's business, no matter how frequently nor completely the city's administrative or legislative bodies might change in political complexion. This enabled him to produce very economical results in the operation of these departments; and he had the final satisfaction of seeing all his efforts for the public welfare appreciated by the best citizens of Milwaukee.

The success of Mr. Benzenberg's various undertakings for the city attracted general attention; and he has been frequently called to advise on municipal works for other cities and as arbiter in cases of disputes. He has been repeatedly called in as consulting engineer on commissions or otherwise by Chicago, Kansas City, Cleveland, New Orleans, Cincinnati and many smaller cities, as well as by a large number of private water companies and by many other private corporations.

At Cleveland he successfully recovered and completed the new large water-works tunnel under Lake Erie after the work had been abandoned by the contractors and many lives had been lost.

For some years past most of Mr. Benzenberg's time has been devoted to the completion of the great new water supply system for Cincinnati.

During 1893 he was President of the American Water Works Association, and some years later was the first active President of the American Society of Municipal Improvements, of which he was one of the organizers. He has also held other positions of trust, and has been for several years a member of the Board of Trustees of the Northwestern Mutual Life Insurance Co. He became a member of the American Society of Civil Engineers in 1883, and served the Society as a Director from 1895 to 1897, and as Vice-President in 1901-02.

*Chief Engineer of the Chicago, Milwaukee & St. Paul Ry. since 1863. Mr. Whittemore by his 44 years of service in this position undoubtedly holds the record for continuous service as Chief Engineer of a single railway company. In addition it may be noted that he is the oldest living Past-President of the American Society of Civil Engineers.

Frederick Remsen Hutton: President of the American Society of Mechanical Engineers.

By Hon. WM. H. WILEY,* M. Am. Soc. M. E.

Frederick Remsen Hutton, the recently installed President of the American Society of Mechanical Engineers, was born in New York City, May 28, 1853. He belongs to Holland stock, on his father's side from the Troy district and on his grandmother's side from the Ulster County region, being descended from the Van Wycks and Brinkerhoffs of that section. His mother was born in New York City.

After preparation in a private school in New York, he entered Columbia College and received the degree of A. B. in 1873. He then entered the School of Mines and took the degree of E. M. in 1876. One year thereafter he was appointed Instructor in Mechanical Engineering, as associate of the late Prof. W. P. Trowbridge. He entered the faculty as Adjunct Professor in 1881 and became Professor in 1890.

On the death of Prof. Trowbridge in 1892 the Chair of Engineering which he had occupied was divided, and the professorships in Civil Engineering and Electrical Engineering were added to the already existing professorships of Mining and Mechanical Engineering. Since that time to the present, Prof. Hutton has been the head of the Mechanical Engineering Department.

Perhaps his most significant achievement during these years of service has been the development of the great mechanical laboratories of Columbia University, during the period from 1897 to 1900, just subsequent to the transfer of the institution from the downtown site to its present location on Morningside Heights, New York City. The equipment of these laboratories includes a Baldwin locomotive and its testing equipment, a triple-expansion Allis-Reynolds engine, and the hydraulic equipment of the Henry R. Worthington Laboratory. A conservative estimate of the value of this equipment as installed is not far from $100,000.

Prof. Hutton believes that experiments made in illustration or confirmation of engineering formulas on engines or machines of small size, introduce an error not only of degree but of kind, and that therefore the units should be of sufficient size to guard against this difficulty; furthermore, that research should be made in new fields sufficiently near to the actual conditions of practice so as not to prove misleading when their results are applied.

Prof. Hutton also believes in conducting laboratory instruction so as to compel the student to exercise his thinking faculty not only in devising experiments and connecting up the apparatus, but also in the interpretation of the results. As a result of his earnest efforts and methods of conducting laboratory instruction, Columbia University has graduated during the years of his professorship some of the ablest of the younger corps of engineers.

Columbia has recognized his achievements in the field of Engineering Education by giving him the honorary degree of Ph.D. in 1882, and in 1904, on the occasion of its 150th anniversary, the degree of Sc.D., which is the highest honor that it confers in the field of science.

In 1883 the American Society of Mechanical Engineers desired to appoint a new Secretary. The Society had then been organized only three years and was feeling the usual embarrassments of a young society, both financially and in other directions. The choice of the Council fell upon Prof. Hutton, and he began with an office at 17 Cortlandt St. and a clerk to operate the office and attend to routine. This clerk's salary he paid out of the meager compensation of that day. The Society seemed to feel at once the infusion of new energy and began a career of increasing prosperity under successive Presidents. The work quickly outgrew the modest first office and was moved to the Stewart Building, from which again the growth of the library forced it to larger quarters at 67 Madison Ave.

*Of the firm of John Wiley & Sons, 43 East 19th St., New York City. Member of Congress from the 8th New Jersey District. Treasurer of the American Society of Mechanical Engineers from 1884 to 1907.

It was the Secretary's energy and ambition which compelled the conservative Council of that day to give favorable consideration to the project of purchasing the house at 12 West Thirty-first St., New York City, in 1890. The writer of this, who at that time and since then has been a member of the Council, recalls very well the earnest way in which Prof. Hutton urged the move to the new quarters, arguing (and events have since justified his contention) that the Society would make much more rapid advancement if it had accommodations suited to its needs. The recent sale of that house at twice the purchase price of 16 years ago is a gratifying confirmation of the financial wisdom of the step which was then taken.

The Secretary was the responsible factor in arranging the details of the trip of the Society to England and France in 1889, which was the first undertaking of its sort and which was of such great benefit in giving international position and recognition to the Society. Indeed, the writer can mark the new position which the Society took, not only abroad but in this country as well, as dating from its trip to Europe, and the grand recognition given it by the greatest engineering society of England, namely, the Institution of Civil Engineers. During that trip, Prof. Hutton was constantly called upon to respond to the glad welcome given by the British engineers; and the writer, who was present with him on all these occasions, can bear testimony to the fact that his remarks were instructive, interesting, and abounded in wit and humor. The Society chartered an entire steamer for its use on the way over, and those who took part in the trip still retain pleasant memories.

The Secretary has been an active member of the Trustees and Building Committee appointed by the Society of Mechanical Engineers for the consideration of the problems raised in connection with the new building of the engineering societies—the gift of Andrew Carnegie in 1904. Prof. Hutton has been the Secretary both of the Building Committee and of the Trustees which are the holding corporation for the Societies. He has given much time and thought to the problems brought up in the planning of the building and in the consideration of much detail which could not be taken up in the larger body. His services in this connection cannot be overestimated, and it is believed have been thoroughly appreciated by all the members of the three societies who are designed to occupy this building. The American Society of Mechanical Engineers, as a signal mark of its appreciation, at once desired that he should fill the highest office in its gift, and it may be said that no one else was mentioned for the office of President, nor, indeed, was any one besides him thought of.

He resigns the Secretaryship of the Society at the threshold of the new building and just as the Society enters into the new phase of its existence, which will be the result of the conditions at the Thirty-ninth St. site; he will be the first President of the Society after its occupation of the new building, and this, in some sense, will be a tribute and perpetual reminder of his great services in connection with its construction.

From the nature of his duties in Columbia University and in the Society's office, with their complete absorption of his available time, it has been impossible for Prof. Hutton to undertake any very considerable creative work in engineering practice or in the consulting field. His contributions to engineering have therefore been restricted to the work of an expert before the courts and in patent cases, and as a contributor to the scientific literature of the day. His three most important books have received considerable acceptance in the educational field in the United States and England. They are "The Mechanical Engineering of Power Plants," "Heat and Heat Engines," and "The Gas Engine." The one first mentioned is used as a text-book in some of the technical institutions of Japan.

Besides these important works, he has contributed to the Transactions of the American Society of Mechanical Engineers, both over his own name and with unsigned contributions, memorial monographs, contributions to discussion and the like. He has been asked to act as Associate-Editor in such work as the revised edition of Johnson, and last of all in an effort to fevise, simplify, and bring up to date scientific and engineering titles in the Century Dictionary. This work was held up last winter by the strike in the printing houses of the city, but is completed as far as the letter L at present writing. He has also been Departmental Editor of the Engineering Magazine and a contributor to other technical journals. He has lectured before scientific and popular audiences in New York and elsewhere at various times. Although the duties named would seem to be all that one man could accomplish, nevertheless the Professor has served as Superintendent of the power plant of Columbia University and as consulting engineer upon its extension from time to time from 1879 to 1890; also as licensed engineer of the plant from 1879 to 1888.

He was Dean of the Faculty of Applied Science and Engineering at Columbia University and had charge of administration and discipline from 1899 to 1905. When the dean function was changed so that a head of department conducting instruction could not also serve as dean, the deanship was offered to him, but he declined. He is a trustee of various benevolent, educational and religious bodies, a member of the American Academy of Arts and Sciences, American Institute of Mining Engineers and of sundry New York clubs.

The growth of the American Society of Mechanical Engineers from 600 members in 1883 to 3,000 in 1906, and its financial strength, which at the present time shows a surplus of over $100,000, are due largely to the untiring efforts of its Secretary. Prof. Hutton is extremely amiable, courteous, and possessed of infinite tact, which has smoothed over many matters promising trouble for the Society. He has an excellent command of language, both in his writings and in his speech, and has been an ideal Secretary. That he will make an ideal President of the Society is the belief and prediction of all his friends, and the writer is certain that the close of 1907 will be a fulfillment of this prediction and of the wishes which go with him in his office.

Robert W. Hunt: President of the American Institute of Mining Engineers.

It has become the general rule in American national engineering societies to elect each year a new president. The office is rightly regarded as the highest honor which an engineer can receive at the hands of his professional associates, and one which may well be bestowed on a new candidate each year. It has occasionally happened, however, that a president of marked distinction has been chosen for a second or even a third term. The American Institute of Mining Engineers, however, has this year elected as its president one of its members who occupied the presidential chair in the institute 24 years ago.

Mr. Robert W. Hunt was president of the institute in 1883 and the office was again bestowed upon him at the last annual meeting. This means that for a quarter of a century Mr. Hunt has remained in the very front rank of distinguished American engineers. It may be added that for over 50 years Mr. Hunt has been actively engaged in professional work.

Robert Woolston Hunt was born Dec. 9, 1838, at Fallsington, in Bucks County, Pennsylvania, and was educated in the public schools of Covington, Ky. Later he removed to Pottsville, Pa., and spent several years in the rolling mills of John Burnish & Co., learning the practical details of iron manufacture by actual work at puddling, heating, rolling, etc. Following this, he studied analytical chemistry in the laboratory of Booth, Garrett & Reese, of Philadelphia, Pa. In August, 1860, he entered the service of the Cambria Iron Co., establishing and taking charge of a chemical laboratory at its works at Johnstown, Pa.; this was the first analytical laboratory to be operated as a department of any iron or steel works in America. Mr. Hunt temporarily left the service of the Cambria Co. to assist his cousin, Thomas W. Yardley, in starting an iron rail mill at Elmira, N. Y., which plant was in successful operation so long as the use of iron rails continued.

When the Civil War occurred, he entered the United States military service, serving as Commandant of Camp Curtin, at Harrisburg, Pa., with the rank of captain, and later as mustering officer for the State of Pennsylvania, with the same rank. He returned to the employment of the Cambria Co., but the war continuing, again enlisted, this time as a sergeant in Lambert's independent company of cavalry, having tossed up (and lost) with a friend as to which should be a lieutenant of the company.

On his retirement from military service, Mr. Hunt returned to Johnstown, and was on May 1, 1865, sent by the Cambria Co. to represent it at the experimental pneumatic (Bessemer) steel plant at Wyandotte, Mich. While Winslow, Griswold & Holley had built an experimental plant at Troy, N. Y., under an arrangement with Bessemer, an association of other iron and steel companies had built another plant at Wyandotte, under the patents of Wm. Kelly and Robert Mushet. Mr. Hunt assumed charge of this in July, 1865, and remained for about a year, when he returned to Johnstown, the Cambria Co. intending to erect a Bessemer plant at once. This was not commenced for several years, however, but in the meantime he took charge of the rolling of steel rails by that company in its Johnstown mill; the ingots were produced in the Pennsylvania Steel Co.'s works at Steelton, Pa., the latter company's rail mill not being completed. These were the first commercial steel rails rolled in America, all previous rails having been experimental, and not to apply on orders.

Mr. Hunt assisted George Fritz, chief engineer of the Cambria Co., in designing and erecting a Bessemer plant for that company, and assumed charge of its operation upon its completion in July, 1871.

In September, 1873, Mr. Hunt left the Cambria Co. and entered the employ of John A. Griswold & Co., of Troy, N. Y., taking charge of their steel plant. Later, upon the consolidation of that company with Corning & Co., of the same place, he became the general superintendent of a new organization known as the Albany and Rensselaer Steel and Iron Co., and (still later) of its successor, the Troy Iron and Steel Co.

In 1888 he resigned, removing to Chicago, and establishing the now well-known firm of Robert W. Hunt & Co., inspecting and consulting engineers, having offices both in this country and in England.

Besides Mr. Hunt's former service as president of the American Institute of Mining Engineers in 1883, he was president of the American Society of Mechanical Engineers in 1891 and of the Western Society of Engineers in 1893. He is also a member of the American Society of Civil Engineers, and of the three leading engineering societies of Great Britain—the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Iron and Steel Institute. He has contributed liberally to the papers and discussions of the several societies, and has taken out a number of patents in both America and Europe. The best known of his patents are those relating to power tables for rail mills, under which practically all of the American rail mills are now operating.

In December, 1866, he was married to Miss Eleanor Clark, of Ecorse, Mich.

Dr. Samuel Sheldon: President of the American Institute of Electrical Engineers.

By CHAS. L. CLARKE,* M. Am. Inst. E. E., M. Am. Soc. M. E.

Dr. Samuel Sheldon is a notable example of that type of men most numerous in America, but found in all lands, who have worked their way up in the world through their native energy. Starting in boyhood with practically no other capital than good health, sanguine temperament and a virile mind inherited of sturdy progenitors,

*Electrical and Mechanical Engineer, 120 Broadway, New York City.

he has, through honesty of purpose and by persistent industry and firm grasping of opportunity, wrought honorable success, consisting largely in eminence attained as an experimental physicist, educator, electrical engineer and scientific writer.

Dr. Sheldon was born March 8, 1862, at Middlebury, Vt., a direct descendant from the Sheldons of Brailes House, Warwickshire, England. In boyhood he received the usual common school education obtainable in a small New England town. At the age of 13 years, as editor of a diminutive four-page monthly newspaper, entitled "Boys' Herald," of which he was likewise compositor and printer, he disclosed a practical literary talent, childlike though it was, which in mature years found expression in the condensed and simple form, and markedly attractive style that characterize his lectures and writings.

In 1879 he entered Middlebury College, taking the regular classical course. He was a hard-working student, particularly excelling in mathematics, physics and philosophy. It must not be assumed, however, that his college life was all work and no play. He perforce must have some form of recreation; and we find him diverting his mind and, incidentally, disclosing his versatility by music, which resulted in his becoming organist of the college chapel choir, and of the choir in St. Stephen's Church. And those who to-day are familiar with the humorous side of his nature, his buoyant spirit and keen enjoyment of good-fellowship, cannot doubt but that he was socially as popular with his college mates as he was high in favor with his instructors. He was graduated, in 1883, with the degree of A. B., and remained at Middlebury two years as instructor in mathematics. In 1887 he received the degree of A. M.

Deciding to make teaching a profession, and desiring to better equip himself for this work, especially in physics, he determined to continue his studies abroad. In the fall of 1885 he entered the University of Würzburg. The celebrated physicist, Kohlrausch, who was then at the university, soon selected him to assist in special investigations, among which was his classic determination of the ohm for the Bavarian Government; later he was made university assistant in laboratory physics. At Würzburg, Dr. Sheldon acquired that thorough knowledge of methods, and a skill in physical manipulation that were to serve as the main foundation for his future success. He was graduated in 1888, with the degree of Ph. D. His graduating thesis, entitled "Wechselströme und Electrolyte," embodied an account of the various methods of determining the ohmic resistance of electrolytes, and a comparison of results obtained by him, particularly with reference to the method of Kohlrausch, involving the use of alternating currents.

Returning to America the same year, Dr. Sheldon was at once made first assistant in physics, under Prof. John Trowbridge, in the Jefferson Physical Laboratory at Harvard University. While at Harvard, Prof. Trowbridge and Dr. Sheldon, in collaboration, conducted experiments on the magnetism of nickel and tungsten, and the neutralization of induction, the results of which were embodied in papers presented before the American Academy of Arts and Sciences.

The next step in Dr. Sheldon's advancement was his call to the Polytechnic Institute of Brooklyn. Founded in 1853, and starting practically as a local institution of learning, the reputation and influence of the Brooklyn Polytechnic have been steadily increasing, until it stands to-day in line with the well-known universities and colleges of the country.

In 1889, the increase in the number of its students and the extension of its work made it advisable to surrender its charter and incorporate a new institution with power to enlarge its educational facilities and keep up with the growing demands of the times. This made immediate additions to its staff imperative; and Dr. Sheldon was called to the chair of physics, and also made professor of the new course of electrical engineering. These positions he has filled for 17 years, with increasing credit to himself (not only as a teacher, but also as an administrator in organising and managing the departments in his charge), with great benefit to the institution, and with priceless advantage to hundreds of students. Under the teaching and guidance of this master in physical manipulation and his trained experienced mind, the graduates of the Polytechnic Institute have gone forth to do their world's work well grounded in knowledge of scientific principles, adept in applying them, and schooled to habits of concentrated discriminating thinking and logical reasoning.

While it may truly be said that the science of physics is so old, and has become so stable that the necessity for marked change in the curriculum of that branch of college teaching seldom arises, such has not been the case with the art of electrical engineering. New electrical discoveries and inventions for their application are continually being made. More than once has it happened that improvements over electrical apparatus, representing the investment of millions of dollars, have made such apparatus obsolete and caused its relegation to the scrap heap within a few years. This progress in discovery and invention has made the art of electrical engineering one of continuous evolution. With its advances, Dr. Sheldon has always kept himself thoroughly informed, and has modified the methods or enlarged the scope of instruction in electrical engineering at the Polytechnic, to keep it abreast of the practical requirements demanded by the commercial state of the art. He is the ideal educator because he ever co-ordinates theory with practice.

Dr. Sheldon has embodied the results of several of his experimental researches in papers and reports presented before learned societies, and in articles that have appeared in scientific journals. He has also written many electrical articles of a popular character.

Among Dr. Sheldon's papers and writings, in some instances in collaboration with others, are: The Magnetism of Nickel and Tungsten Alloys, Trowbridge and Sheldon, Amer. Jour. Sci., [3] xxxviii, 462-5, 1889; Neutralization of Induction, ibid., [3] xxxix, 17-21, 1890; The Magneto-Optical Generation of Electricity, Sheldon, ibid., [3] xl, 196-8, 1890; The Electric Blowpipe, Sci. Amer., lx, 68, 1889; Electrical Waves, Pop. Sci. Monthly, xxxv, 509-14, 1889; The Storage of Electricity, ibid., xxxviii, 355-63, 1891; The Critical Current Density for Copper Deposition and the Absolute Velocity of Migration of Copper Ions, Sheldon and Downing, Phys. Rev., i, 51-8, 1893; The Capacity of Electrolytic Condensers, Sheldon, Leitch and Shaw, ibid., ii., 401-11, 1895; On the Formation of Lead Sulphate in Alternating Current Electrolysis with Lead Electrodes, Sheldon and Waterman, ibid., iv, 324-29, 1897; The Electromagnetic Effect of Electrolytic Currents, Sheldon and Downing, ibid. vii, 122-3, 1898; Determination of Self-Induction Coefficient by Means of a Weber Inductor, Elec. Eng., New York, xi, 217, 1891; A Method for Determining Temperature Coefficients of German Silver Wires, Sheldon and Burnett, ibid., 651-2; The Preparation of Copper Samples for Conductivity Tests, Sheldon, ibid., xxv, 319, 1898; The Precise Comparison of Very Small Resistances, Elec. World, xxxi, 296, 1898; The Reliability of Magnetic Tests Made with a d'Arsonval Ballistic Galvanometer, Sheldon and Cocks, ibid., 735-6; The Hysteretic Qualities of Iron Viewed from the Molecular Standpoint, Elec. World and Eng., xxxv, 211-12, 1900; Concerning Rail-Bonds, Street Ry. Jour., xvii, 650, 1901; Conditions of Electrolytic Corrosion in Brooklyn, Trans. Amer. Inst. Elec. Eng., xvii, 339-50, 1900; The Electrochemical Industries, ibid., xix, 281-94, 1902; Concerning Uniformity in the Electrical Engineering Courses in the United States, ibid., 1151-4; Some Recommendations Concerning Electrical and Mechanical Specifications of Trolley Insulators, Sheldon and Kelley, ibid., xxii, 231-9, 1903; A Few Experiments with Holtz Machines [included in the 1903 report of the Committee on Current Classification and Nomenclature to the American Electro-Therapeutic Association], Jour. Advanced Therapeutics, New York, xxii, 148-53, 229-34, 280-4; Further Experiments with Electrostatic Machines [included in the 1904 Report, ibid.], ibid., xxiii, 150-164, see also first erratum on page 408.

Dr. Sheldon's reports to the Electro-Therapeutic Association, mentioned above, constitute a most valuable contribution to science, and to the art relating to electrostatic machines. Through his experimental investigations and conclusions derived therefrom, the mode of operation of electrostatic machines has definitely been determined, and for the first time their efficiency accurately measured. The efficiency of such machines under good working conditions was found to be very high compared with what it was generally thought to be, amounting, when the machine is used as a generator, to nearly 50%.

The value of Dr. Sheldon's text-book contributions to science and engineering has received well-merited recognition. The fourth edition of Olmsted's College Philosophy, entitled, "An Introduction to Natural Philosophy," appeared in 1891, revised by Dr. Sheldon. The work had been allowed to fall far behind the times and had gone practically out of use. Upon the publication of the fourth edition, however, it at once met with a large sale and became the standard text-book on physics in many colleges and academies.

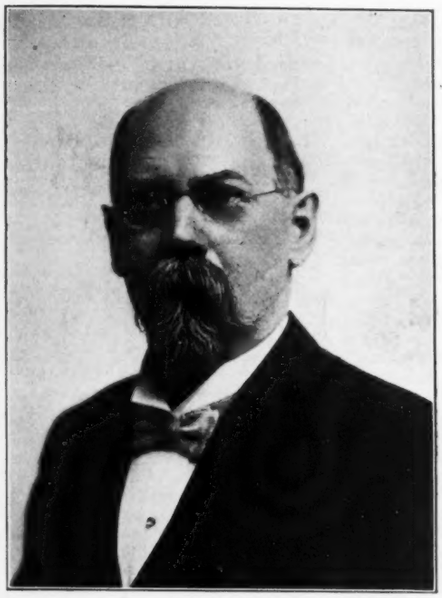
Dr. Sheldon is the author of Vol. I, and joint author, with Hobart Mason, of Vol. II., of "Dynamo Electric Machinery; Its Construction, Design and Operation," the sub-titles of which are, respectively, "Direct-Current Machines" and "Alternating-Current Machines." The first volume was issued in 1900, and has already passed through six editions; the second, first issued in 1902, has passed through four editions. Both volumes have met with extensive sales. He was also a contributor to Foster's "Electrical Engineer's Pocket-Book."

The ability with which Dr. Sheldon is able in suitable language to explain scientific principles and their practical application, and make them understood to the layman, has brought his services in demand as a popular lecturer. He has delivered courses to the public under the auspices of the Department of Education of New York City, and is frequently called upon to lecture before local clubs and societies interested in electrical and mechanical arts. His quickness to grasp the essential points of any popular question relating to electrical matters, his pleasing manner of expounding them, and his cosmopolitan ways make him the favorite of reporters, and his "interviews" will be found scattered through the columns of the daily newspapers.

Dr. Sheldon was admitted to the American Institute of Electrical Engineers, as associate, Dec. 16, 1890, and became a member on Oct. 27 of the following year. He served as manager six years, vice-president two years and was five years on the committee on papers, four years as chairman. His devotion to the interests of the institute as a member and in all the official positions he held, his executive ability, the untiring zeal with which he performed the duties of chairman of the committee on papers, and his success in inducing the presentation for several years of an unusually large number of papers of special interest and value, his prominence in the science and application of electricity outside the institute limits and the faculty he has always possessed of making a friend of every man he met if he could, and in any event never making an enemy, marked him for some time as a rising candidate for election to the presidency of the institute. He was elected in the spring of 1906 for the term of 1906-7, and was installed in office last September.

He is also a member of the American Electrochemical Society, the New York Electrical Society, of which he is past-president, fellow of the American Association for the Advancement of Science, member of the American Physical Society, Society for the Promotion of Engineering Education, honorary fellow of the American Electro-Therapeutic Association, member of the National Electric Light Association and president of the Department of Electricity of the Brooklyn Institute of Arts and Sciences.

His latest honor is the degree of Sc. D., conferred last summer by the University of Pennsylvania.



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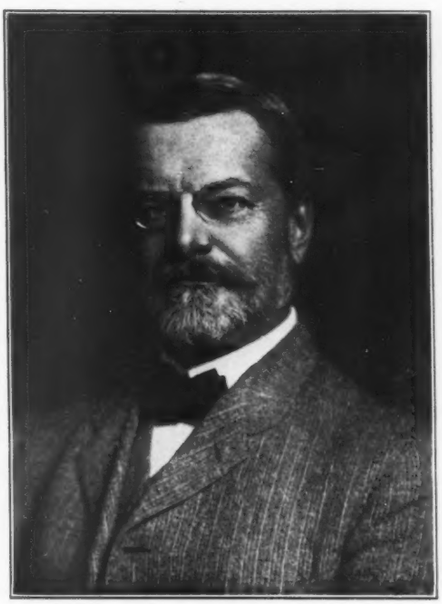

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Under East Orange conditions (which should be noted before applying the data to any other city), utilizing garbage and rubbish as fuel seems to be warranted, while the use of ashes borders on the questionable. But in either case the justification for burning the refuse is sanitary rather than economic, since the capital and operating charges for utilizing the refuse are far in excess of the cost of an equivalent amount of coal. The latter conclusion is not a surprising one, but if given due consideration would moderate the exaggerated claims which are sometimes made for the heat value of municipal refuse.

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To our mind one of the strongest arguments for giving the building department control of plumbing construction is the great resulting convenience to builders, since all the plans and specifications incident to a building could then be filed in one office, instead of part with the health and part with the building department. Another strong argument for vesting the inspection of plumbing construction with the building department is that the health department can better use such men and money as are at its command in other lines of health-protective work, of far more vital concern to the public. These include, first of all, everything leading to the early discovery of communicable diseases and their origin, and second, every possible means of preventing the spread of communicable disease. Plumbing, we now understand, has very little to do with these matters, although it may have a marked effect on the general health of individuals. But in so far as plumbing may be related to either general health or the spread of disease, its installation may be just as readily controlled by an honest, capable building department as by an honest, capable health board, while without honesty and efficiency the control or pretended control in either case may be worse than useless through giving household[illegible] and others a false sense of security.

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It should be understood that in o[illegible] the property on the relation of plumbing to [illegible]set line and ease[illegible] are voicing our own o[illegible] corner, because echoing those of Mr. Ball, who [illegible] up this subject in his paper. It [illegible] understood that the desirability of the [illegible] inspection of all plumbing, after insta[illegible] by boards of health is not involved in this [illegible] cussion, which relates solely to construction work, either new or in the nature of additions or alterations.

A counterweight device for operating an electric railway in Sydney, Australia, on a grade steeper than the 10% which is generally accepted as the maximum allowable with ordinary methods, is described in a paper elsewhere in this issue. Such counterweight devices are not wholly novel. Originally designed and patented in this country by Mr. J. P. F. Kuhlmann, of Seattle, Wash., they have been used at Portland, Ore., Seattle, Providence, St. Paul, and perhaps elsewhere. The Sydney installation, however, has been worked out with much care as to details and is deemed worthy of record.

The general principle of these counterweight systems is doubtless familiar to most of our readers. A small subway is made down the hill on which protection to the electric cars is desired and a heavily weighted car with cable attached runs in this subway. When an electric car is to descend the steep grade it is attached to the other end of this cable and in descending

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We cannot conclude without expressing regret that the local data for such studies as Mr. Floy has made are generally so very meager, as was the case at East Orange. Had more reliable data as to the relative amounts of different classes of waste been available it is probable that the detailed figures presented would have been considerably altered, and possible, though not probable, that the broad general conclusions of the report might have been affected. Some day, it is hoped, our cities, large and small, will awaken to the advantage of accurate, comparable municipal statistics.

The relation of plumbing inspectors to other city officials has recently been discussed in a commendable manner by Mr. Chas. B. Ball, M. Am. Soc. C. E., in a paper which we abstract elsewhere in this issue. Mr. Ball's former positions of chief plumbing inspector of Washington, D. C., and chief sanitary inspector of the New York Tenement House Commission, are warrant for giving heed to his ideas on this subject. A particular question raised by him is whether plumbing inspection should be under the jurisdiction of the health or of the building department of a city. All things considered, we agree with him that this work, meaning of course plans for and the installation of plumbing, should be controlled by the building department. Exceptions might be made in the case of progressive small cities, where the need for a health department would be recognized and met sooner than the need of a building department.

To our mind one of the strongest arguments for giving the building department control of plumbing construction is the great resulting convenience to builders, since all the plans and specifications incident to a building could then be filed in one office, instead of part with the health and part with the building department. Another strong argument for vesting the inspection of plumbing construction with the building department is that the health department can better use such men and money as are at its command in other lines of health-protective work, of far more vital concern to the public. These include, first of all, everything leading to the early discovery of communicable diseases and their origin, and second, every possible means of preventing the spread of communicable disease. Plumbing, we now understand, has very little to do with these matters, although it may have a marked effect on the general health of individuals. But in so far as plumbing may be related to either general health or the spread of disease, its installation may be just as readily controlled by an honest, capable building department as by an honest, capable health board, while without honesty and efficiency the control or pretended control in either case may be worse than useless through giving householders and others a false sense of security.

It should be understood that in our remarks on the relation of plumbing to health and disease we are voicing our own opinions and not echoing those of Mr. Ball, who does not take up this subject in his paper. It should also be understood that the desirability of the periodical inspection of all plumbing, after installation, by boards of health is not involved in this discussion, which relates solely to construction work, either new or in the nature of additions or alterations.

A counterweight device for operating an electric railway in Sydney, Australia, on a grade steeper than the 10% which is generally accepted as the maximum allowable with ordinary methods, is described in a paper elsewhere in this issue. Such counterweight devices are not wholly novel. Originally designed and patented in this country by Mr. J. P. F. Kuhlmann, of Seattle, Wash., they have been used at Portland, Ore., Seattle, Providence, St. Paul, and perhaps elsewhere. The Sydney installation, however, has been worked out with much care as to details and is deemed worthy of record.

The general principle of these counterweight systems is doubtless familiar to most of our readers. A small subway is made down the hill on which protection to the electric cars is desired and a heavily weighted car with cable attached runs in this subway. When an electric car is to descend the steep grade it is attached to the other end of this cable and in descending

course on the main trunk lines vastly heavier traffic than this is moved; and it therefore follows that the branch and local lines move a very much smaller amount. Probably there are not at the present time over 50,000 miles at the outside, out of the 220,000 in the United States, on which the main line trackage facilities are not ample to move all the traffic that will be offered for many years to come. We are not, therefore, up against the problem of increasing track facilities on all our 220,000 miles of railway but only on those main lines where the traffic has outgrown the capacity to handle it.

Turning now again to Mr. Hill's letter we quote as follows:

The limit of service of a common carrier has been reached when it has moving at all times over its system as many cars as can be run on its tracks with safety and transferred and dispatched from its terminals and junction points without unreasonable delay. Beyond that point increase of business cannot be handled by increasing cars and engines.

The best judgment of many conservative railroad men in the country is that an immediate addition of not less than 5% per annum to the railroad trackage of the country for, say, five years, should be made to relieve the situation and put an end to unreasonable delays in the transaction of business.

Investigations recently made by public officials and facts accessible before those investigations disclose that the railroads of the country have been endeavoring to meet the growing demand upon them. They have utilized as never before the carrying capacity of each mile. Not only were there 35% more locomotives and 45% more cars in service in 1905 than in 1895, but each engine and car did much more work. The passenger miles traveled per locomotive increased from 1,218,967 to 2,048,558, or more than 68%, and the ton-miles per freight locomotive from 4,258,221 to 6,690,700, or more than 57%. Trains run faster, cars are larger, locomotives are more powerful, and methods of handling the business have so improved as to increase the general efficiency.

In the great centers the inadequacy of terminal facilities prevents the free flow of traffic. The Great Northern Railway Company has 34 switch engines in use in the Twin Cities, while only 28 engines are used in hauling freight into and out of the same.

Suppose that only 25% additional track, with necessary terminals and equipment, making 33%, is to be built during the next five years, or, say, in round numbers, 75,000 miles of track, as the requirement for the country to meet immediate needs. No practical man would furnish the facilities required, including additional equipment and terminal facilities, for less than $75,000 a mile. The question of terminals alone is almost prohibitive. Terminals now in use were acquired when property was cheap, and can be enlarged only by heavy outlays. In many cities it is not even a question of cost, since the area necessary to handle railroad business properly is not to be had at any price.

The new work, then, would amount to $5,500,000,000 in round numbers, or a yearly average of $1,100,000,000. That is the sum which should be spent before the commerce of the country can be moved properly.

The basis of Mr. Hill's computation is evident from the above quotation; and our preceding analysis shows its essential error. He is correct in stating that there is need for additional trackage, and particularly for additional terminal facilities; but his attempt to measure the total requirement as a percentage of the total existing mileage is manifestly too inaccurate to have any standing.

The actual situation as we see it is this: A considerable proportion of the main lines of railway west of Chicago need to be double-tracked. Something has been done in this direction during the past half dozen years; but the job needs to be tackled on a much larger scale. The Great Northern, for example, has only 90 miles of double-track on its system over 6,000 miles in extent, according to the last report before us. The Northern Pacific has 120 miles. Both these companies have been extensively engaged in building branches which have brought more traffic to the main line; and they must now turn their attention to increasing the traffic capacity there.

In this connection it may be pointed out that for the best service to the public at the least capital outlay, our railway system ought to be made up of double-track main lines with a suitable network of feeders rather than of a large number of single-track lines. The traffic capacity of a double-track railway is very much more than double that of two single-track lines. The railway development of the '70's and '80's gridironed the country in many sections with a larger mileage of single-track main lines than could be supported. The growth of traffic since that time has made profitable many railway lines which then were bankrupt; but there is no need of repeating the costly mistakes of a generation ago. Additions to railway capital in most sections of the country can far better be devoted to double-tracking and enlarging yards and terminals than to building new competing through lines.

Turning now to the problems presented by congested terminals, we wish to express our hearty approval of the concluding portion of Mr. Hill's letter. We quote as follows:

The prohibitory expense now attached to enlargement of terminals at many points, and the absolute lack of available space at any price, may be met by a decentralization of traffic. There must be more points for export, more interior markets.

Terminal troubles admit of a more general diffusion of business, permitting transfers to take place and forwarding to be done where land can be secured in adequate quantities and at more reasonable prices. To this the traffic systems of the country must be adjusted. The heavy transfers must be made away from the larger cities.

No student of transportation problems, who has watched the rapid growth of terminal expenses, can fail to reach conclusions similar to those of Mr. Hill's. It is to the public advantage that the number of exporting points be increased; that the development of rival grain markets to Chicago and Minneapolis and Duluth be encouraged, that new jobbing centers be given a chance to grow. We are well aware that this is all opposed to the ideas commonly held; nevertheless it is sound doctrine. New York must learn that it is not to her advantage to have such concentration of traffic at her doors as to congest all her railway yards and her streets and wharves. It is an advantage to all concerned that a portion of the export trade has been diverted to Boston and Newport News and Galveston. Chicago has lost its old preëminence as the sole market of the West, and a vast amount of business which she formerly controlled now goes to the Gulf, to the Lake Superior ports and eastward via all-rail routes. Were this not the case, the congestion of Chicago's railway terminals would be far more serious to-day than it is, and her prosperity would be correspondingly endangered.

In this connection, too, it is well to call attention to the importance of diverting through freight traffic around cities instead of carrying it through them. A beginning has already been made in this direction, but much more remains to be done. Eventually all our main line railways will be able to divert their through freight trains around the large cities on their lines with a resultant great saving in cost and time of transport.

In the same letter of Mr. Hill's from which we have already quoted he says:

The average speed of a freight train is from 12 to 15 miles an hour. The average distance traveled by each freight car is about 25 miles a day. That is, the entire freight equipment of the country is employed to the fair limit of its capacity only two hours out of the twenty-four. On single-track lines freights must wait on sidings while passenger trains have the right-of-way; cars stand for days or weeks in yards or at transfer points awaiting their turn.

Here is the real root of the difficulty of the railways in dealing with congestion of traffic. It is all very well to reduce the delays of shippers and consignees in loading and unloading cars; but these delays actually account for only a very small proportion of the car's time. It is not the delays on the road, either, that account for the lost time of the car to any large extent. It is the delays in yards and terminals that chiefly account for the long interval between the dispatch of a carload of freight and its receipt at the other end. How to lessen these delays so as to keep cars moving; how to so design yards and terminals that the present congestion can be overcome, these are the main problems which must be solved to enable the railways to handle their rapidly growing traffic.

LETTERS TO THE EDITOR.

A Record for Rapid Railway Location in Prairie Country.

Sir: The Brandon-Regina location of the Grand Trunk Pacific Ry. in Canada which was recently made by Mr. C. J. Seymour is, I belive, a record for prairie location. The figures are as follows:

Location, 218 miles; alternative location, 90 miles; preliminary, 175 miles. Total, 483 miles in 84 days, an average of 5.75 miles per day. The big day's run was 12.46 miles "location" in 8 hrs. and 20 mins. An average of 8.34 miles was made for 22 days in September. Do you know of any record of greater mileage made anywhere?

Yours very truly,
D. D. MacCrimmon.

Box 68, Winnipeg, Man., Jan. 9, 1907.

Shrinkage of Maps and Errors of Draftsmen's Scales.

Sir: I have some flat and some triangular scales, of the white or celluloid-edged wooden style, purchased from leading supply houses at different times in the last 15 years. I have used these constantly in both public and railway offices, without complaint from my several employers. My present employer, however, an assistant city surveyor, is inclined to condemn these white-edged wood scales for map-making, and claims none but a steel scale should be used for city or railway work. I should like to hear the opinion of other draftsmen and engineers as to the accuracy of work done by white-edged scales, and whether any greater accuracy can really be gained by using steel scales instead.

I will admit that the steel triangular scale is a trifle more accurate, because the wooden scale will sometimes warp slightly; but that trifle can hardly be seen by the naked eye on a full 12-in. length in a plan drawn on Whatman mounted paper. If the white-edged scales are not reasonably accurate and reliable, how is it that the various supply houses have a hundred orders for these against one for metallic scales? Besides, different draftsmen separately scaling a distance of, say, three scale-lengths, would differ in their measurements by at least 2 to 2½ ft. on scales of 20 to 50 ft. to the inch. This difference is fully as great as that which is claimed to exist between wood and steel scales. In a map 36 × 25 ins. on Whatman paper mounted on cloth, I have known a shrinkage of 2 to 4 ft. (on scales of 40 to 60 ft. to the inch) to occur in 6 months to a year. I should like to hear from others what allowance, if any, they customarily make for this; and also what their opinion is as to shrinkage of record maps for deeds, etc., drawn on mounted paper.

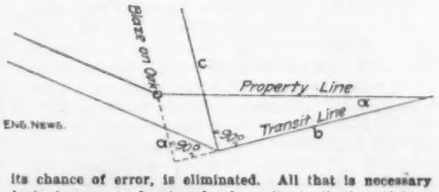
Yours respectfully,
"A Subscriber."

Some Suggestions Regarding Property Surveys.

Sir: I read with a great deal of interest the article by Mr. Tidd in this week's issue of Engineering News on the property surveys for the Croton Falls Reservoir. There is only one little criticism that I would make. It is of the method employed in getting the property corner in Fig. 4. Mr. Tidd runs an offset line and establishes a station near the property corner, because the corner itself cannot be occupied; and from this he gets the angle and distance to the corner.

The method I use and which I think is a decided improvement on this both in time, accuracy, and usefulness of data obtained, is to proceed as he does in running the offset line and establishing a station near the property corner, but then I would get the corner by right-angle location, i. e., get the coordinates of the corner with reference to the transit line and the station.

The advantages of this method are: First, the measurement of an angle having odd minutes and seconds, with



its chance of error, is eliminated. All that is necessary is to turn a quadrant and take a "swing"—then if it is wished to check by doubling the angle it is easy to lay off 180°. Second, from the information obtained, the bearing of the property line can be computed directly in one operation, for the length of transit line plus or minus the swing to property corner from the right-angle offset line c, will give b, and $\frac{a}{b} = \tan \alpha$. The length of x (the property line) can be derived directly from this.

I have often thought that in city work where a lot of right-angle location of this kind is required, a small telescope at right angles to the main telescope and resting on its trunnions would be extremely useful. It

pulls the counterweight up the hill. When the car climbs the grade the descending counterweight assists it.

The counterweight section at Sydney is about 600 ft. long and has a grade of 10 to 12%. The counterweight exerts a pull on the cable of about 3,000 lbs. The total cost of the counterweight installation was about $30,000.

It occurs to us that a variation of the counterweight system which might in some locations be installed at much smaller cost and certainly with much less obstruction of the street surface in construction, would be to place the counterweight in a bored well, instead of in a subway on the incline to be operated, as has been done hitherto. A bored well 600 ft. in depth could be usually made, we judge, at a small fraction of the cost of the 600-ft. long subway under the street for the counterweight car. A lead counterweight 8 ins. in diameter to run in a bored well would need to be only 12 ft. long to give 3,000 lbs. pull on the cable, equal to that of the 12-ton counterweight car used on the Sydney line. Possibly there may be inherent objections to such a vertical counterweight system as we have suggested that would make it unwise to use it; but the idea seems to be at least worth investigation.

It will be evident, of course, that the traffic capacity of any counterweight system is so limited that it is certain to be of very limited application. On the Sydney line referred to, only one car every 20 minutes is handled. While considerably greater capacity than this would doubtless be possible, a limit is set by the time necessary for a car to descend the incline, discharge its passengers, take on a fresh load and return to the top. It is to be noted also that the longer the incline, the longer must be the interval between cars and the smaller the traffic capacity.. It is this controlling factor that has led to the gradual abandonment of several forms of cable inclines which were in more or less extensive use twenty years ago.

The newspapers of late have given wide currency to sensational reports that recent borings at Gatun on the site of the locks and the dam had shown unsatisfactory foundations. It has not been at all difficult for those familiar with the past history of the canal enterprise to trace these rumors to their source. Just such stories were set afloat a year ago, when the sea level canal advocates and the advocates of special plans for construction were fighting by every means in their power to defeat the adoption of the lock canal plan. Those who are familiar with the tactics then employed will not be surprised at any sort of manufactured rumor that may be set afloat.

The general public, however, is of course unable to judge between the true and the false in these published reports; and the well-known tendency of many newspapers to print what is sensational regardless of its truth or its origin, gives publicity to much that is wholly false and misleading.

The outcome of these various sensational reports was a request by the Senate Committee on Canals, transmitted to the Canal Commission on Jan. 8, for authentic information on this subject. We print below the reply to this request:

Hon. J. H. Millard, Chairman Committee on Interoceanic Canals, U. S. Senate.

Sir—I have the honor to acknowledge the receipt of your letter of Jan. 8, stating that at a meeting held that date one of the members of your committee reported that the borings for the Gatun locks and for the locks on the Pacific side had been found very unsatisfactory, and that the Pacific locks had been changed two or three miles from the original location; and requesting complete information relative to borings before the next meeting of the committee, to be held Jan. 15.

I have caused to be prepared by those members of the Engineering Committee of the Commission now in Washington (Messrs. Endicott, Hains and Harrod) a statement with respect to the inquiries set forth in your letter, and transmit the same to you herewith.

In order, however, that you might be advised of the results of all borings and investigations of a later date than those of which the Engineering Committee was advised, which included all those up to the time of its latest visit to the Isthmus in November, last, a cable was sent to the Chief Engineer, Mr. Stevens, requesting that he advise me of the result of all borings to date, to which the following reply has been received:

"One hundred and twenty-seven holes have been bored Gatun lock site, covering area 1,200 by 5,000 ft. All carried well below bottom lock walls, and 66 to depth of 50 ft. or more below sea level, and all show that lock walls will rest on firm and suitable soft rock. Thirty-six borings made covering area of controlling gates for spillway. All show safe formation in soft rock. Three lines of borings, 67 in number, all extending to rock, have been made across Valley Chagres, covering dam site. Pervious material in only four holes and these below 200 ft. Pedro Miguel lock walls: Ten borings have been made below foundations, all showing rock suitable for foundations. Test pits Gatun and Pedro Miguel so far all show harder material than cores from borings."

While the report of the members of the Engineering Committee and the cable from Mr. Stevens, relate primarily to the lock sites, your attention is called, nevertheless, to the statement that "there is nothing in the later examinations made affecting the practicability or permanency of the Gatun dam."

Very respectfully,

T. P. Shonts, Chairman.

Jan. 14, 1907.

Mr. T. P. Shonts, Chairman Isthmian Canal Commission.

Sir—In compliance with the request of Senator J. H. Millard, referred to the Engineering Committee, it has the honor to transmit the following information concerning the borings at Gatun, accompanied by plans of all borings that have been made heretofore. This information is as full and complete as possible, including everything bearing on the subject of the Senator's letter, which is on file in this office.

[Here follows list of blue prints sent, which we omit.—Ed.]

The Comission at its meeting on Nov. 20, 1906, directed the continuance of examinations to furnish information for the designing of locks, by sinking test pits under the lock walls, and the testing of block samples from these pits, to determine the bearing power of the material and other physical characteristics.

The materials disclosed by the observations of the strata underlying the lock site show, below the surface soil, either what is denominated by the engineers in the field as "indurated clay" or "chopped sand and clay." These terms may be misleading. The chopped material is different from the "indurated clay" and seems to be a sort of hardpan or conglomerate, either of which will make a good foundation. Referring to the physical, and not to the geological character of these formations, the "indurated clay" has a rock-like consistency which resists compression and erosion, and makes an entirely satisfactory foundation for the proposed lock structures. This is established by the borings and by the exposures of the material in the French work at the dry dock at Cristobal.

By the term "chopped," in connection with the other material, is designated the method found most rapid and economical in penetrating it with boring tools. While a diamond drill was used in the so-called "indurated clay," a chopping bit was found most useful in the other material. It could have been taken out in cores by a diamond drill, and, in fact, this process was used at times. The terms are not intended to convey an impression of the value of their physical properties for a lock foundation. An opinion of the relative values of the two materials for foundation purposes is expressed in correspondence by Mr. Stevens, Chief Engineer, as follows:

"It will be noted that under the so-called indurated clay in cross sections 1, 2 and 3 exists what is called blue clay and sand—clay, gravel and fine sand, etc.

"This material, while not so hard as the so-called indurated clay, is in every respect an equally good and sufficient foundation, in my opinion, for the locks, or a structure of any weight or importance. In fact, if there were not a particle of indurated clay in Gatun Hill, I would not have the slightest hesitancy in founding the whole structure on this material.

"I beg, in this connection, to enclose under separate cover, a sample of this material, which was taken as a core from the borings, as it is found in cross section 1, as the material underlying the indurated clay, and I think you will agree with me that there is no doubt whatever as to its character for foundation purposes. I believe it is as good as indurated clay, and good enough in any case."

We know of no foundation for the report "that the proposed lock on the Pacific side has been changed some two or three miles from the original point designated." The locks, both at Pedro Miguel and Sosa, occupy substantially the sites chosen by the minority of the Advisory Board. These locations were necessarily general. When special examinations were made it was found that the rock foundation for the locks at Pedro Miguel did not extend over the entire area covered by the structures and a slight shifting of their position may be advisable, but there have been no other changes contemplated.

In conclusion, we state that the investigations which the Commission has continued have thus far led to no disclosure of extraordinary difficulties requiring changes of previous plans. The continuation of surveys has for its object the complete adaption of the design of locks and other features of the plan to the existing surface and sub-surface conditions.

There is nothing in the later examinations made affecting the practicability or permanence of the Gatun dam.

Very respectfully,

Mordecai T. Endicott,
Chairman Engineering Committee.

Jan. 12, 1907.

CONCERNING RAILWAY EXTENSIONS.

Public attention has been attracted during the past week by a letter written to Gov. Johnson of Minnesota by President Jas. J. Hill of the Great Northern R. R. Co. The gist of this letter is that the railway systems of the country are congested with more traffic than they can well handle, that the only remedy for the congestion is an enormous increase in railway facilities, necessitating a huge investment of capital; and that in order to obtain that capital the state and national governments must let the railways alone, lest the investor be frightened away. The letter is of course drawn out by the action of Minnesota officials in delaying approval of the Great Northern's proposed stock increase.

The stupendous size of Mr. Hill's estimate for needed railway expansion is what has challenged attention. He figures out that $5,500,000,000 ought to be spent on the United States railway system during the next five years to enable it to properly handle business. As the present capitalization of all the railways of the United States, water and all, is less than 16 billion dollars, in round numbers, this means that according to Mr. Hill, our present railway system taken as a whole, ought to be increased one-third in extent in the next half decade. Admitting the need of largely increased facilities by the railways, we see no justification for so vast an increase in so short a time as is here proposed. Let us examine Mr. Hill's argument a little more closely. At the outset of his letter he submits, as proof that the railways of the United States have been standing still when they ought to have been growing, the following figures:

A striking tale is told by the statistics of railroad building in the United States. Not only is it true that there has been in the ten years ending with the year 1906 an increase of but 21% in mileage, but the most impressive fact is that railroad building has within a generation fallen off just as the demand upon trackage has increased. At this moment, when that demand is greatest and the whole country is clamoring for relief, it is the smallest in years. These are the figures:

Year.	Total mileage.	Inc. P. C.	Inc. P.C. Pr. An.
1870	52,808	....	....
1880	93,671	77	7
1890	163,597	74.6	7.46
1904	213,904	30.75	2.19
*1906	220,000	2.9	1.45

*Estimated.

Before forming any conclusions from the above statistics, we ought to ask, What do they really represent? From an extended experience in compiling statistics of annual railway construction, we can say that the great bulk of this mileage represents extensions into new country, or spur or branch lines. Only a very small proportion of the mileage built is through lines, designed to divide the business with existing lines and lessen traffic congestion thereon. Now whether the country builds 5,000 miles or 12,000 miles of these branches and extensions in a year has little bearing on the question whether the main line railways are doing all they ought to increase their facilities. In fact, if there had been 20,000 miles of these extensions built in the last two years instead of 7,000, the main line railways instead of being relieved would have had a far bigger burden of traffic to handle.

If it were true that all the 220,000 miles of railway in the United States is congested with traffic, then indeed we would be face to face with a condition demanding even huger expenditures of capital than Mr. Hill calls for; but it is not true. The bulk of this 220,000 miles is made up of branches and local roads. The average railway in the United States, taking the country as a whole, carries annually as a transporting machine only about 100,000 passenger miles and about 1,000,000 ton miles per mile of line. That means about 300 passengers and 3,000 tons of freight to be moved per day. Of

Lackawanna & Wyoming Valley R. R." No award of the Collingwood Prize for Juniors was made.

COMMITTEE REPORTS.—The Board of Direction has had under consideration during the past half year the matter of establishing a special committee to investigate the status of engineering education in this country. As a result the Board rendered a report at the present meeting, in which it gave arguments for and against such investigation, and made recommendation in favor. Thereupon the meeting voted to take a letter-ballot of the Society on the same question of whether or not such a committee should be appointed. Before this decision was reached, however, Mr. John F. O'Rourke (New York City) made a vigorously-worded protest against the Society's investigating the everlasting subject of engineering education, with the certainty of fruitless results. But the supporters of the movement carried the day with a vote safely above the necessary two-thirds.

The committee on Uniform Tests for Cement made a progress report, stating that it is conducting experiments and that its work is not in such shape as to be reported. The committee was continued.

The committee on Rail Sections also reported nothing to report. At the Thousand Islands convention of last summer (see Eng. News of July 5, 1906, p. 22) this committee made complete majority and minority reports, the majority report giving specifications for manufacture, but leaving the rail-sections unchanged; the Society, however, concluded that a united reported was possible and referred the subject back to the committee. The work of the past half year in this direction has evidently not sufficed to bring about the desired result. The committee was continued.

The committee on Concrete and Reinforced Concrete gave a somewhat fuller statement of its condition, but it also had no results to report. It has found the work of compiling and collating previous results to be a greater labor than was anticipated, and has secured the assistance of the Society's library organization for the bibliographical searches. It will conduct tests in the Structural Materials Testing Laboratory of the U. S. Geological Survey, at St. Louis, Mo., utilizing the government appropriations (the present one being available until June, 1907). College laboratories will aid in the testing work. The results found by the committee are to be published in monthly or bi-monthly bulletins when the work is under way, in order to make the results known without delay.

MEMBERSHIP QUALIFICATIONS.

The report of the committee on Amendments to the Constitution (which amendments concern only the prescriptions as to requirements for admission to the Society) is the outcome of a reconsideration following the recommittal of amendments proposed by the committee at the Thousand Islands convention. The discussion and action of that convention (Eng. News, July 5, 1906, p. 22) should be referred to if a general view of the situation is desired. The principal point of contention last summer was the proposed clause requiring candidates for admission as Members to have attained a "*recognized* position of *honorable high standing* in the profession." In the new draft submitted at the present meeting by the majority of the committee this clause is changed to require merely "honorable standing in the profession," and in this form it seems to be satisfactory, for the discussion did not refer to this phrase. A minority report was rendered by Mr. J. C. Trautwine, Jr., in which among other variations this phrase was absent.

The inclusion of Architect among the professional grades conferring eligibility to the Member class, in the majority report, again caused strong opposition. Mr. W. J. Baldwin moved that the word be stricken out, pointing to the fact that this could not be interpreted as offensive to the architectural profession because the American Institute of Architects jealously excludes all but architects from its full membership. Most architects could not earn admission to the American Society of Civil Engineers as engineers, and those who could are eligible on that account. Mr. E. P. North recalled that the Society's original name was American Institute of Civil Engineers and Architects, but that when it was recognized that most architects are merely decorators the title was changed. Mr. C. C. Schneider proposed as a substitute for Section 3 the following:

A Corporate Member shall be a professional engineer practicing in any branch of the profession.

Mr. Geo. A. Soper quoted Morison's "New Epoch" in support of the proposition that Civil Engineering is not a coordinate branch of engineering but has an inclusive signification. This is reflected in the minority report, and he urged the acceptance of the respective clause of this report. Mr. A. S. Ives made a motion to substitute this clause for Mr. Schneider's, but on the initiative of Mr. E. P. North the motion was amended by omitting the last part of the clause, a subsidiary phrase. The substitution was carried. Prof. G. S. Williams then moved to strike out the clause in question, but unsuccessfully. Without further vote, then, the substituted clause was considered advanced to letter-ballot.

Sec. 4, which specifies definitely the requirements for admission as Member, was also discussed at much length, but it was finally passed to letter-ballot just as it was reported by the majority of the committee. Prof. G. S. Williams attempted two changes: first, to ensure the inclusion of a graduate's first few years' work by substituting "actively engaged in engineering work" for "in the active practice of engineering"; second, to make the work of a professor of engineering equivalent to work in "responsible charge of engineering work of importance." Both attempts failed, although the second had the support of Prof. G. F. Swain and Prof. L. J. Johnson. Mr. E. P. North moved to change the age limit of Member from 33 to 30, but the motion was lost. The substitution of "high standing" for "honorable standing" also failed.

In discussing the requirements for Associate Member, Mr. C. W. Hunt, secretary, objected to the phrase "of importance" in defining the nature of work which the applicant had in charge; he asserted that many men passed a lifetime in work which would never qualify them for admission as Member but should still admit them as Associate Member. Criticisms were also passed on the requirements for Associate; one wanted the section phrased so as to exclude all professional engineers, while another thought the last clause as recommended misleading and indefinite, and wanted it omitted. But all these proposals failed and the remaining amendments were passed to letter-ballot just as reported by the majority of the committee.

The sections affected are given below in the form as passed for letter-ballot. They are to be adopted or rejected as they stand by the letter-ballot, and are not subject to further modification.

ARTICLE II.—MEMBERSHIP.

1. The membership of the Society shall be classified as follows: Honorary Members, Members, Associate Members, Associates, Juniors and Fellows.

2. The Members and Associate Members shall constitute the Corporate Membership of the Society.

3. Corporate Members shall be persons who are, or who have been, engaged in the profession or work of civil engineering in its broad sense, including its several branches.

4. A Member shall be not less than thirty-three years of age; shall have been in the active practice of engineering for at least ten years, shall be qualified to design and direct engineering works; shall have had responsible charge of engineering work of importance for at least five years, and shall have attained honorable standing in the profession. Graduation from a school of engineering of good reputation shall be considered equivalent to two years of active practice. The performance of the duties of a professor of engineering in any of its branches in such a school shall be considered equivalent to active practice.

5. An Associate Member shall be not less than twenty-five years of age; shall have been in the active practice of engineering for at least six years, and shall have had responsible charge of engineering work of importance for at least one year. Graduation from a school of engineering of good reputation shall be considered equivalent to two years of active practice. The performance of the duties of a professor of engineering in any of its branches in such a school shall be considered equivalent to active practice.

6. An Honorary Member shall be a person of acknowledged eminence in some branch of engineering or the sciences relating thereto. There shall be not more than twenty Honorary Members at any one time.

7. An Associate shall be one who by scientific acquirements or technical experience has attained a position in his special pursuit qualifying him to cooperate with engineers in the advancement of professional knowledge and practice, although he may not be a professional engineer.

8. A Junior shall be not less than twenty-one years of age, and his connection with the Society shall cease when he becomes thirty-two years of age, unless he shall have been transferred to another grade of membership. He shall have been in the active practice of engineering for at least two years, or he shall have been graduated from a school of engineering of good reputation. The status of Juniors elected prior to March 4, 1891, is not changed by the provisions of this section.

9. A Fellow shall have contributed to the permanent funds of the Society. After July 1, 1907, admission to the grade of Fellow shall be discontinued.

10. Honorary Members, Associates, Juniors and Fellows shall be entitled to all the privileges of the Society except the rights to vote and to hold office. Corporate Members elected to Honorary Membership shall not thereby forfeit their rights as Corporate Members.

A minor change was also made in Sec. 2 of Art. III., specifying that the Board of Direction may, before recommending an applicant to ballot, require evidence to show that he possesses the necessary qualifications for admission.

The letter-ballot for officers for the coming year gave the following result:

President, George H. Benzenberg, of Milwaukee, Wis.; First Vice-President, John A. Bensel, of New York City; Second Vice-President, John A. Ockerson, of St. Louis, Mo.; Directors, Allen Hazen (New York City), George W. Tillson (New York City), Frank W. Hodgdon (Boston, Mass.), James Christie (Philadelphia, Pa.), Horace E. Horton (Chicago, Ill.), Arthur L. Adams (San Francisco, Cal.); Treasurer, Joseph M. Knap, of New York City.

The following were elected as new members of the Nominating Committee: Joseph Strachan (New York City), Otis Clapp (Providence, R. I.), Robert Ridgway (New York City), Charles Davis (Pittsburg, Pa.), Ira O. Baker (Champaign, Ill.), Hunter McDonald (Nashville, Tenn.), John F. Coleman (New Orleans, La.), Joseph B. Lippincott (Los Angeles, Cal.).

ANNUAL CONVENTION OF THE INDIANA ENGINEERING SOCIETY.

The 27th annual meeting was held at the rooms of the Commercial Club, Indianapolis, Ind., on Jan. 17, 18 and 19, with an unusually large attendance. At the opening session on the afternoon of Jan. 17, the report of the Secretary was presented by Mr. C. C. Brown. This showed a membership of 187. The financial report showed $1,056 receipts and $1,006 expenditures. A number of papers and reports were presented, but there was, as a rule, very little comment or discussion upon these. A dinner, given by the local members, was held at the Denison Hotel on the first evening. On the second afternoon there was a visit to the new Board of Trade Building (Brubaker & Eldridge, architects and engineers). A special electric car then took the party from the building to the Atlas Engine Works, where a couple of hours were spent in inspecting the different departments of the plant, including the new department for the manufacture of the gas engines.

The address of the president, Mr. Robert P. Woods (Indianapolis & Western Ry.), dealt with the engineering of electric interurban railways. The year 1899, he said, marked the beginning of the high-speed long-distance interurban service brought about through the agency of a central power station with alternating current and using high-tension transmission lines, rotary converters and substations. The eight years of progress since then have seen changes in electrical transmission by the direct-current, the three-phase and single-phase alternating current, and the new 1,200-volt direct-current methods.

An outline of the principal factors and ele-

could also act as a striding level by having a bubble attached, but this is not necessary, as the same result could be obtained by having it parallel with the main transit and have a prismatic arrangement for the right angle.

Yours truly,

Wm. MacDonald.

Assistant Engineer, Board of Public Works, Richmond Borough, New York City, Jan. 11, 1907.

THE NEW PLANT OF THE FERRACUTE MACHINE CO.

The new plant of the Ferracute Machine Co., at Bridgeton, N. J., is a good illustration of a modern machine building plant of moderate size operated entirely by individual electric motors. These works replace the old plant which was completely destroyed by fire something over a year ago. As shown in Fig. 1, the pattern shop is located next to the office, which makes it handy to the drafting room. Next to the pattern shop is located the storage room for patterns, then comes the carpenter shop, engine room and boiler room. These five shops are all under one roof, but are separated by brick walls. The roof is slag, the timber-work of "mill construction," and the whole building is equipped with automatic sprinklers and fire-doors,

The machine shop is built entirely of brick and steel. The only wood in the building is the tops of the benches, and these are protected on the underside by sheet-iron. A spur from the West Jersey & Seashore R. R. enters the yard of the works, one branch entering the machine shop and the other passing along the side of the boiler house and pattern shop as seen in Fig. 1. The machine shop has three bays. The middle one, used as an erecting department, is now served by a 20-ton Niles electric crane and a 10-ton Pawling & Harnischfeger electric crane will soon be added. The side bays are each served by a 5-ton Niles crane.

All the machinery of the plant is driven by electric motors, each machine being fitted with its individual motor. Current is supplied to these motors by two 75 KW. Curtis horizontal turbines, driving D. C. generators, delivering 220-volt current. Steam at 150 lbs. pressure is generated by a 250-HP. Heine water-tube boiler. At present the plant is operating non-condensing, although arrangements have been made for installing condensers.

The special feature of the boiler room is the arrangement of the coal bin. As seen from Fig. 1 this is located directly beneath the railway spur, so that by removing covers, a coal car can be dumped quickly into the bin. By this arrangement the coal flows by gravity down to the front of the boilers. Located between the machine shop and power-house is a building used for a locker and wash room and assembly

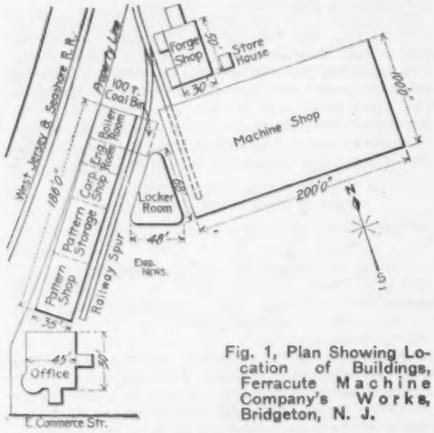


Fig. 1, Plan Showing Location of Buildings, Ferracute Machine Company's Works, Bridgeton, N. J.

hall. Space is provided for 200 lockers, which are fitted with keyless "Star-point" locks, the invention of Mr. Oberlin Smith, President of the company. The water in the wash room is heated by steam, the mixer being provided with a thermometer for determining the temperature of the mixed water and steam. Each man can wash under an individual jet or in the trough beneath.

The different styles of motor drive seen in the machine shop are worthy of note, as showing how ordinary belt driven machine tools can have electric motors applied. The majority of the machines here have been thus converted, some being remodeled, while others have simply the counter shaft mounted upon them. This work of remodeling was done by the company in its own shops, because of the time, space and money that could thus be saved. The cost of remodeling the machines is said to have been about one-half the price asked by the tool manufacturers.

Fig. 2 shows a Reed lathe having the motor mounted upon a platform fastened to the head of the lathe. In this case the cone has been removed from the lathe and a spur gear substituted. This spur is driven by a pinion mounted on an auxiliary shaft, which is belted to the motor. In other cases the motor is mounted directly on the head of the lathe and the pinion placed on the end of the motor shaft. In the cases where the counter shaft is mounted on a frame work, the motor is mounted on a swinging shelf which permits tightening the belt. Fig. 2 also shows an arrangement of cord and idling pulleys whereby the lathe may be started, stopped or reversed from any position along its bed. Gear ratios for all the remodeled machines have been made 3 to 1 and all motors are made for field control, with a speed ratio of 3½ to 1. It is stated that this arrangement gives entire satisfaction and that no trouble is experienced from the motors sparking.

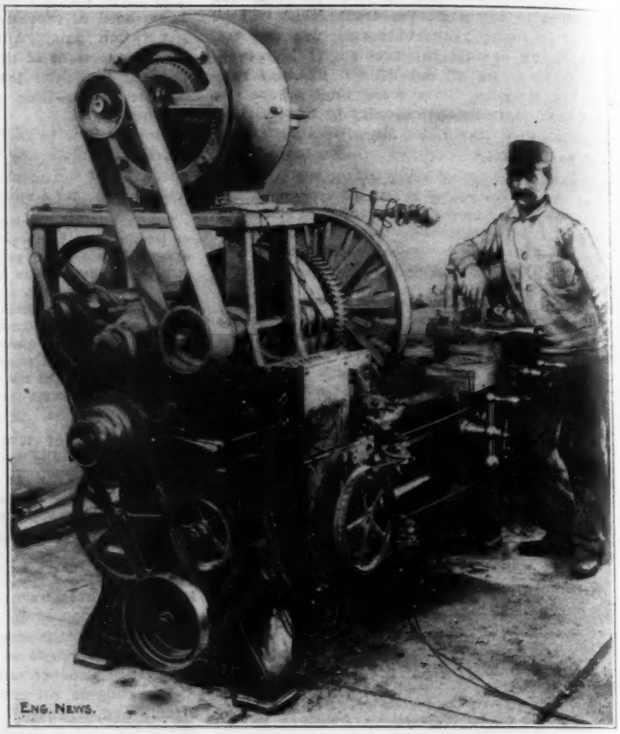


Fig. 2. Lathe with Electric Motor Mounted on Head Showing Arrangement of Gear Transmission and Rope Control of Field Rheostat.

The tool room is provided with all-metal tool racks, which consist of an angle-iron steel frame into which are placed, one on top of another, formed up pieces of sheet-iron. These formed sheets have the shape of flat bottomed V-threads alternately reversed, so that when two sheets are placed together, hex openings are made extending through the rack. This arrangement requres a minimum of space and gives a fireproof rack, besides being very cheap to build.

All hand cars, trucks, etc., about the works have been fitted with roller bearings in order to reduce the number of workmen required to move a load. All power wires to machines are run in flexible armored conduit.

In remodeling the various machine tools, the size of motors required was largely determined by experiment. To facilitate this work the company had the Bristol Recording Instrument Co. make them a special wattmeter, which is calibrated in horsepower and makes a complete revolution in five minutes. By connecting this instrument in the circuit of a motor, the horsepower required for doing various kinds of work on the machine can be read off at a glance.

In the forge-shop the forges and furnaces are provided with down-draft, a common chimney being located at one end. This arrangement allows a traveling crane to run the whole length of the shop.

A doorless dark room is found in connection with the drafting department. This consists of a passageway lapping back on itself three times so that it is impossible for exterior light to get into the room from this passageway, and it also permits entrance or exit at all times, regardless of the work going on in the room.

The Ferracute Machine Co. manufactur[illegible] kinds and sizes of foot and power presses [illegible] dies for working bar and sheet metals, [illegible] cloth, leather, etc. Some of these presses [illegible] nearly 50 tons; with a ram pressure of 500 [illegible] Mr. Oberlin Smith, Past-President Am. Soc. M[illegible]

is President and Mechanical Engineer of the company, and the building and equipment of the shops has been under his direct supervision.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The fifty-fourth annual meeting of the American Society of Civil Engineers at New York last week was a well-attended social gathering which devoted several hours to a consideration of revised membership qualifications. As a result of the meeting a set of constitutional amendments was passed to a general vote of the society; judging by the general sentiment expressed at this meeting and at the Thousand Islands convention last summer (where the same subject was discussed), they stand a good chance of adoption.

The meeting covered Wednesday and Thursday, Jan. 16 and 17. It was opened with a business session on Wednesday morning, the only working session. On Wednesday evening Mr. Eugene Lentilhon delivered an address on "Chile," giving a lantern-slide survey of the lands and people of that progressive South American republic. The address was followed by a smoker, which lasted from 9 o'clock onward. Thursday was occupied by a steamer excursion to the new steel plant of Milliken Bros., Inc., at Milliken, S. I. The trip was made in a typical blizzard, a small but active copy of its Western prototype, but over six hundred people made the trip, many ladies among them. A theater-party the same evening wound up the meeting.

AWARD OF PRIZES.—The Norman Medal was awarded to Capt. John Stephen Sewell, of Washington, D. C., for his paper, "The Economical Design of Reinforced-Concrete Floor Systems for Fire-Resisting Structures." The Thomas Fitch Rowland Prize was awarded to Messrs. G. B. Francis and W. F. Dennis, of New York City, for their paper "The Scranton Tunnel of the

ments entering into the building of interurban railways would include the following: (1) organization; (2) franchises; (3) contracts; (4) specifications; (5) materials of construction; (6) details of construction; (7) distribution of accounts; (8) blank progress forms and reports on projects. It might appear that some of the subjects given are not properly within the engineer's duties, but as a matter of fact they are all included. The economics of the project, the cost of materials and labor (so valuable to the engineer for present and future use), and many of the essentials of a franchise (often entailing purely engineering matters) should all be well-known to the engineer. It is not meant that he should become the attorney, the accountant or the promoter, but there are certain features of their knowledge which he also should possess.

A paper on "Paving Between Street Railway Tracks and Rails" was read by Mr. B. J. T. Jeup, of Indianapolis. In that city brick is now almost exclusively used for this purpose. Prof. H. O. Garman (Purdue University) presented the report of the Committee on Electric Railways, and Mr. Union B. Hunt, State Railway Commissioner, gave some account of the work and duties of the commission. Mr. D. V. Moore presented the Report of the Committee on Concrete in Building Construction, which included a paper by Mr. J. Kahn on "Reinforced Concrete Construction."

GASOLINE ENGINES.—At the morning meeting on Jan. 18, Mr. L. O. Danse, of the Atlas Engine Works, Indianapolis, described the design and special features of a new gas engine now being built by that firm. It is of the four-cycle type, horizontal, with center crank; the smallest sizes are vertical with enclosed crank case and valve chamber at the side of the cylinder instead of in the cylinder head. Special features are the close regulation of speed and the exceptional ease of starting. It is guaranteed to develop 1-HP.-hour on 0.1 gallon of gasoline. These engines are being built in sizes of 2 HP. to 24 HP.

REINFORCED-CONCRETE SEWER.—Mr. M. L. Morris, Assistant City Engineer of South Bend, Ind., described the construction of the Fassnacht Ave. trunk sewer, of which 5,887 ft. have been constructed, 72 ins. and 66 ins. diameter. It has a 9-in. ring of a 1:2:4 mixture in the crown and 1:3:6 in the invert. The concrete was made as wet as it could be conveniently handled. The outside was made vertical from the center line to 18 ins. above the base of concrete, for convenience of construction and for additional strength. The reinforcing consists of steel bars $^5/_{16}$ × 1 in., spaced 12 ins. c. to c.; each rib is in three pieces; the two side pieces straight (but bent at right angles at the lower end to anchor them), and fastened to the arch or hoop piece by cotter pins, the connection being made 5 ins. above the center line. The steel is 2 ins. from the inner face, and after the removal of the forms the lower half of the face was given a ½-in. coat of 1 to 1 cement mortar. The contractors were Hoban & Roach, and the cost per lin. ft. was as follows:

Concrete in sewer proper	$2.10
Reinforcement	.30
Striking and removing forms	.45
Setting forms and templates	.35
Plastering	.38
Subdrain pipe	.33
Labor laying drain pipe	.35
Handling water from trench	.45
Excavation and backfilling	2.80
Setting and pulling of curbing	1.04
Tools and general expenses	.50
Total	$9.00

In the discussion the efficiency of the cotter pin connections in developing the strength of the steel was called in question. It was also suggested that with such a thickness of concrete the cost was nearly as much as brick, but it was stated that this was adopted to give ample strength, and that the cost was actually lower than for brick work that could be compared with it. The cost of the reinforcement was but a small proportion of the total.

TRACK ELEVATION FOR INDIANAPOLIS.—Three papers were presented dealing with this subject. Mr. C. C. Brown, formerly City Engineer, stated that as trains became an obstruction to traffic, the Delaware Ave. viaduct was built in the early '70's, but it was so far from the lines of traffic that it was not used much and was removed in about three years. When the matter was next taken up the viaduct plan was considered, but it was seen that this would be expensive while affording but an inefficient means for transportation between different parts of the city.

Mr. Jeup in his paper stated that in 1898 he was directed to prepare plans to show that track elevation was feasible, and on the basis of these an ordinance was passed in August, 1899, declaring all steam railway tracks at grade to be nuisances and requiring the companies to elevate their tracks; the city was divided into districts and a time set for the completion of the work in each district. In district No. 1, the limit was Sept. 1, 1901, and in April, 1900, the railways were directed to remove or elevate their tracks. Upon their failure to comply with the demand, suit was brought, but the case was decided against the city and the decree sustained by the Supreme Court in a decision rendered in February, 1903.

The legislature finally passed the present track elevation law, and by its terms the companies pay 75%, the city 17% and the county 8%; where there are street railway tracks, the city pays 14%, the county 6%, and the street railway company 5%. The total expenditure in any one year may not exceed $400,000, but the Board of Public Improvements may enter into a contract with the railway company for an improvement costing more than this amount.

Mr. J. W. Stearns then presented a paper describing the completed work at Massachusetts Ave. and Tenth St., and the work now under way, which includes West St., Kentucky Ave. and Missouri St. In the completed work the two streets were depressed 3 ft. 6 ins., with grades of 3%, and the tracks were elevated to give 14 ft. 6 ins. clear headway, with approach grades of 1%.

A brief report of the Committee on Bridges and Masonry was presented by Mr. A. J. Hammond (South Bend), and a preliminary report of the Committee on Water-Works by Mr. Charles Brossman, Jr. (Indianapolis). Mr. B. F. Nesbit, Chief Engineer of the Vincennes Bridge Co., read a paper on "Estimates for Steel Highway Bridges," and Mr. L. S. Alter (Goodland) described "An Indiana Drainage Problem."

A SANITARY SURVEY OF WHITE RIVER.

A lengthy paper was then read by Prof. R. L. Sackett (Earlham College) describing a sanitary survey of White River above Martinsville; the watershed is 2,100 sq. miles, and the dry river flow of the river at Indianapolis is 75,000,000 gallons per day. The condition of this river is notorious and may be judged from the following quotation:

> The pollution includes sewage, coal tar from gas plants, oil and salt water from oil wells, straw and lime from strawboard mills, acid and pulp from wood fiber mills; dilute acid from iron, tin-plate and wire mills; animal matter from abbatoirs, meat packing establishments and tanneries; vegetable matter from breweries, distilleries, canning and pickling factories, etc. It is difficult to picture the condition of White River in and below Indianapolis. A black deposit of oily, foul, animal and vegetable matter can be raised from the bed for miles. The woods are coated with grease and with sewage plants. Flats are covered with blackening offal; driftwood collects dead hogs and animal refuse where they putrefy. The odor is distinct for 40 miles down the river. Animals will not drink the water, and it cannot be used for laundry or other domestic purposes when the wells and cisterns go dry. The Chicago River was never so foul, and the Schuylkill River at or above Philadelphia was never half so filthy.

There are places where the chlorine is from 500 to 1,000 parts per 100,000. The serious financial effects of this pollution are in depreciating the value of farm lands along the river, and in compelling municipalities to put in filter plants or obtain new water supplies, which expenditures would not have been necessary but for the pollution of the river. The subject was brought up again at a later meeting, when Mr. C. C. Brown presented a short report from the Committee on Stream Pollution, recommending the readoption of resolutions passed last year calling upon the State to increase the power of the State Board of Health is dealing with this very serious problem.

At the evening session, Mr. M. H. Downey, City Engineer of Anderson, Ind., presented a paper on "The Kankakee Drainage System," accompanied by numerous stereopticon views of the Kankakee River and swamp, the drainage ditching work, and plans of the comprehensive system proposed for the reclamation of this district. Prof. Hatt, of Purdue University, presented the report of the Committee on Materials of Construction, and a short paper on "Unit Stresses for Designing Timber Structures," while Prof. Hancock, also of Purdue University, presented a paper on "The Recovery of Steel and Iron from Overstrain," giving the results of a series of tests.

At the final session on Jan. 20, Mr. C. Brossman, Jr., read a paper on "The Design and Construction of Asphalt Paving Plants," referring to both portable and stationary plants and including the Pittsburg repair plant described in Engineering News a short time ago. The other papers were by professors of Purdue University, as follows: "The Effect of Different Steam Pressures upon the Performance of Steam Locomotives," Prof. W. F. M. Goss; "Principles of the Telephone," Prof. A. B. Smith; "Electric Car Braking," Prof. H. P. Plumb; "Some Tests of a Mercury Vapor Lamp," Prof. A. N. Topping.

The officers for the present year are as follows: President, Prof. W. K. Hatt, Purdue University; Vice-President, D. B. Luten, Indianapolis; Directors, C. E. Watts and Charles Brossman; Secretary, C. C. Brown, Indianapolis, Ind.

NOTES FROM ENGINEERING SCHOOLS.

WORCESTER POLYTECHNIC INSTITUTE.—The new Electrical Engineering Building of the Institute, on which construction is now well advanced, and which will be available for use in September, 1907, or earlier, contains perhaps the largest laboratories for electrical engineering instruction in the world. The cost of the new building will be about $125,000, exclusive of equipment. The building is of red brick with darker red brick and brownstone trimmings, and light green slate roof.

A general laboratory 200 ft. long and 55 ft. wide, containing, with three galleries, a floor area of 19,400 sq. ft. and a volume of about 400,000 cu. ft., extends the entire south side of the main floor. A 10-ton electric traveling crane covers the entire central portion of this laboratory between the galleries, and 2-ton trolley hoists serve the galleries their entire length.

A lecture hall capable of seating 300 persons occupies the west wing of the building, and an overhead trolley hoist will be installed to take equipment from the crane in the general laboratory to the demonstration table in the lecture hall. Above the lecture hall is the standards and research laboratory.

The library and offices are located in the east wing, and above these are the electrical engineering design room, the blue-print room, and recitation rooms.

The general laboratories will contain about 50 generators and motors, and about 40 transformers. For electric railway instruction, two tracks connecting with the tracks of the local railway company enter the laboratory on space covered by a traveling crane. One of these tracks, for purposes of inspection, is for its entire length over a pit. The other track enters a testing plant where a car or locomotive under test rests and runs on wheels which transmit the power from the car to absorption dynamometers.

It is stated that the Worcester Polytechnic Institute was the first institution to provide workshops for the training of engineering students; that it was one of the first, and is at present one of the comparative few, to provide instruction in electrical engineering design; and that it was the first to establish a chair of electric railway engineering.

A $2,000,000 APPROPRIATION FOR COLORADO River control works is under consideration by Congress. The bill authorizes necessary works for river control, and also the construction of irrigation ditches and reservoirs, the cost of the irrigation works to be repaid to the government in so far as they are of direct benefit to water users.

THE EXCLUSION OF THE SEWAGE OF TRENTON, N. J., from the Delaware River has been ordered by the New Jersey State Sewerage Commission. The order is to take effect Jan. 1, 1911.

THE OHIO RIVER has been in flood for the last week up to and in some places above its maximum height recorded in February, 1884. At Pittsburg, the large government dam at Springdale was broken at one bank and the water rushing through the gap inundated the whole adjacent territory, destroying hundreds of smaller houses and jeopardizing the safety of a $500,000 factory. The destructive flow of the water was somewhat abated at this point by blowing a hole with dynamite in the middle of the dam, through which the flood passed. At Cincinnati the water reached a point 15 ft. above the danger line and flooded the entire lowland of the city. All traffic, railway and street, was discontinued at this part of the town. At Louisville the water overtopped the levee and flooded large areas of the resident section. All along the course of the river and its tributaries whole communities have been driven from their homes and property was destroyed to a value estimated by newspaper reports as high as $3,000,000. The flood apparently reached its maximum height at Cincinnati on Jan. 20. In its further passage down the river high water and resulting danger and disaster may be looked for all down the lower Ohio and Mississippi to the gulf.

THE EXPLOSION OF THE BOILER of a Philadelphia & Reading R. R. freight locomotive at Bridgeport, Pa., Jan. 16, killed five trainmen. The locomotive was demolished but the engine driver escaped with slight injuries.

A LOCOMOTIVE BOILER EXPLOSION occurred on the Atlantic City R. R. (Philadelphia & Reading system) on Jan. 20. The locomotive was hauling a passenger train and was running at high speed. Three cars of the train were thrown off the track, but no passengers were injured. Three men on the engine were killed.

TWO VERY SERIOUS RAILWAY ACCIDENTS on the same railway line within a single day are the record of the past week. On the morning of Jan. 19 a butting collision between an eastbound passenger train and a westbound freight train occurred at Fowler, Ind., on the Cleveland, Cincinnati, Chicago & St. Louis (Big Four) Ry. At least twenty persons were killed outright in the wreck and the fire which followed the collision. A dense fog is charged with the blame for the accident. The operator at Fowler was unable to stop the passenger train as the engineer of the latter could not see the signal.

On the evening of the same day a passenger train was wrecked on the same railway, at Sandford, Ind., from an unusual cause. The train passed a siding on which a freight train was standing. It appears that one of the cars near the center of the freight train was loaded with explosives. Just as the passenger train went by, this car blew up and the larger part of the passenger train was destroyed. Over 20 persons were killed. It is stated that an oil pipe-line passes under the roadbed about at the point where the powder-car stood on the sidetrack, and it has been suggested that possibly gas leaking from this pipe-line may have been ignited by the fire in the locomotive and in turn caused the explosion of the powder-car. Some of the survivors speak of two consecutive explosions. The explosive is supposed to have been black powder.

THE KINGSTON EARTHQUAKE did much greater damage than was stated in the early reports noted in our last issue. According to latest information the death list will doubtless reach 1,000 or more, while an equal number were maimed or severely injured. Many of the killed and injured were cremated by the fire which followed the quake. The business portion of Kingston was completely destroyed and the debris consumed by fire, while the Government buildings in the suburbs and all other important buildings were wrecked. The water mains of the city were not seriously damaged, but most of the fire apparatus was destroyed by the falling buildings, thus making the fighting of the flames difficult. All cable offices were destroyed and a temporary office was established some ten miles out of Kingston. The property loss is placed at $30,000,000.

THE TYPHOID FEVER SITUATION AT SCRANTON, Pa., is slowly improving. For the week ending at noon, Jan. 22, 38 cases were reported, making a total of 1,090 cases since Dec. 1. The "official" deaths from Dec. 1 to Jan. 22 numbered 96. The daily number of cases during the past week has been 7, 1, 8, 7, 6, 5 and 4.

TYPHOID FEVER IN MONTREAL AND VICINITY has been causing much concern of late. The disease prevails in those sections of the city and in certain suburbs supplied by the Montreal Water & Power Co., and is attributed to pollution of the water supplied by that company. A similar outbreak, attributed to the same causes, was reported in 1904. The Provincial Board of Health of Quebec has addressed a communication to the City Council of Montreal stating that measures recommended by the Board in 1904 for the improvement of the water supplied by the Montreal Water & Power Co. have not been carried out. The recommendations were that a dam or other works be constructed to prevent "sewage from St. Peter River, Verdun, and upper places, from reaching the intake; filtration of the water before its distribution"; and means of making the water-works intake suction pipe water-tight. The Provincial Board of Health declares

that the said water-works, in its present condition, is a nuisance, and gives notice to the municipalities supplied, in whole or in part, by the water-works in question, to see, without delay, that the necessary measures for the improvement of the Montreal Water & Power Co.'s intake be taken without delay.

A MINE EXPLOSION at Clinton, Ind., Jan. 14, killed eight miners and injured two others. Some 200 workmen had descended into the mine to commence the day's work, when the explosion occurred, but the most of them escaped uninjured. The ventilating system was injured by the explosion and it was necessary to make repairs before a rescue party could enter the mine. The explosion is said to have been caused by a spark from a miner's lamp. The interior of the mine was badly damaged.

THE VALUE OF SUPERHEATED STEAM in locomotive service is to be investigated by Prof. W. F. M. Goss, of Purdue University, under a special grant of $3,000 a year for four years from the Carnegie institution. This is the second grant to Prof. Goss for investigations in locomotive engineering. The work is to be carried on in connection with the regular studies of the Purdue Locomotive Laboratory, supplementing the resources of the laboratory as derived in other ways.

THE ATLANTIC CITY DRAWBRIDGE DISASTER has been investigated by the Grand Jury of Atlantic County and the following presentment was returned by it on Jan. 17:

The Grand Jury at the opening session was instructed by the court to investigate the drawbridge accident near Atlantic City on Sunday, Oct. 28. The jury, after a most careful and thorough investigation both by the examination of many witnesses and by personal inspection of the bridge on which this accident is alleged to have occurred, can find no evidence that would warrant us to hold or even censure Daniel Stewart, the bridge-tender, who is alleged to have had charge of the bridge.

We do find that the West Jersey & Seashore R. R. Co. has been negligent by not seeing that the construction of the bridge was safe for the traveling public. This jury examined the bridge, and at the time of the inspection found the same defective. We found that there were no mechanical signals at either end of the bridge to show that the rails were connected in their proper shape; in other words, one rail or all the rails might be raised out of their proper positions, and the white signal could be given to approaching trains in either direction that all was right.

Further, we believe that the West Jersey & Seashore R. R. Co. should be instructed to have defective rails repaired at the earliest possible date, and, we further recommend that the speed limit should not exceed eight miles per hour over the draw bridge.

GOVERNMENT REGULATION OF NIAGARA POWER under the Burton Act, passed at the last session of Congress, has materialized in the form of a decision promulgated by Secretary of War Taft. The decision permits companies developing power on the American bank to draw respective volumes of water which are practically those now used and authorized as maxima by the Burton Act. The Niagara Falls Power Co. is permitted to draw 8,600 cu. ft. per sec., which is practically the amount now drawn; no larger quantity may be drawn for any purpose, whether power-generation or sluicing. The Niagara Falls Hydraulic Power & Mfg. Co. is limited to 6,500 cu. ft. per sec. for all purposes. Importation of power generated on the Canadian bank is permitted in the following amounts: International Railway Co., 1,500 HP.; Ontario Power Co., 60,000 HP.; Canadian Niagara Falls Power Co., 52,500 HP.; Electrical Development Co., 46,000 HP.; a total of 160,000 HP. The permits are revocable at pleasure by the Secretary of War, and in any event expire on June 29, 1909, in the absence of further legislation by Congress. These permits authorize a total draft of 15,100 cu. ft. per sec. on the American side, now all drawn, and affect about 10,000 to 15,000 cu. ft. per sec. on the Canadian side, of which it is estimated that about 5,000 cu. ft. per sec. will be drawn during the three years of life of the permits; they thus affect about 20,000 cu. ft. per sec., as against a total volume of the falls of about 220,000 cu. ft. per sec.

A radical and highly interesting feature of Secretary Taft's decision concerns the conditions on the brink of the gorge on the American bank. The text says:

As the object of the act is to preserve the scenic beauty of Niagara Falls, I conceive it to be within my power to impose conditions upon the granting of these permits, compliance with which will remedy the unsightly appearance that is given the American side of the canyon just below the falls on the American side, where the tunnel of the Niagara Falls Power Co. discharges and where the works of the hydraulic company are placed.

The representative of the American Civic Association has properly described the effect upon the sightseer of the view toward the side of the canyon to be that of looking into the back yard of a house negligently kept. For the purpose of aiding me in determining what ought to be done to remove this eyesore, including the appearance of the buildings at the top, I shall appoint a committee consisting of Charles F. McKim, Frank D. Millet and F. L. Olmstedto advise me what changes, at an expense not out of proportion to the extent of the investment, can be made which will put the side of the canyon at this point from bottom to top in natural harmony with the falls and the other surroundings, and will conceal, as far as possible, the raw commercial aspect that now offends the eye. This consideration has been kept in view in the construction of works on the Canadian side and in the buildings of the Niagara Falls Power Co., above the falls. There is no reason why similar care should not be enforced here.

A NEW INCANDESCENT LAMP FILAMENT of high efficiency has been produced after long experimenting by Prof. H. C. Parker, of Columbia University, and Mr. W. G. Clark, New York City. The filament is called the Helion filament, and is described by the inventors, in a paper read before the American Physical Society in December, as follows:

The Helion filament is composed largely of silicon which is reduced and deposited, together with the other materials, under very exact conditions. The base which is being used at present is a special carbon filament, on which the necessary deposit is made. The filament is mounted within a globe which is then pumped out, much the same as with the ordinary carbon lamp. . . . The filament, while not metallic in the proper sense, shows a metallic characteristic in that it is possible to fuse parts of it together very much the same as is done with a metallic filament.

The filament has a varying temperature coefficient, which is negative up to about 1,400° C., and then suddenly changes to a small positive value. The power-consumption of the lamp is about one watt per candle-power, as against 3 to 3.5 watts per candle in the ordinary carbon-filament lamp. An almost equally important characteristic is a high overload capacity; a lamp has carried just twice its normal power without showing sign of failure. The lamp promises to show a long life; experimental lamps have shown life-periods of 485 to 1,270 hours, without material decrease in candle-power.

HORSE CARS IN NEW YORK CITY STREETS will shortly be replaced by electric cars. The directors of the New York City Ry. Co. have instructed President Vreeland to proceed at once with the contracts, orders for material, etc., necessary for this change. Work will be commenced on the First Ave. line as soon as the frost is out of the ground. It is proposed to run a main trunk line of the street surface system down this avenue, connecting all the East River bridges. The electrification of the 28th and 29th St. lines will next follow, and, according to President Vreeland, new routes will soon be laid out to reach the important new traffic centers, such as the new Pennsylvania Railroad station, the terminals of the Blackwell's Island Bridge, the Manhattan Bridge, and the Williamsburg Bridge. At the present time the Borough of Manhattan, New York City, is said to have a larger number of horse cars in operation than are to be found in all the rest of the United States. This has resulted from the refusal to permit the erection of overhead wires for the ordinary trolley system. The work now authorized will eliminate all these horse cars except the Belt Line on West St., where occasional high tides prevent the use of the electric conduit system.

THE FOREST RESERVES OF THE UNITED STATES, Alaska and Porto Rico on January 1, 1907, numbered 138, and had a total area of 127,154,371 acres. Alaska had two reserves of 403,640 and 4,506,240 acres, respectively, and Porto Rico one reserve of 65,950 acres. The number and total area of reserves in each State are as follows:

	Number.	Acres.
Arizona	13	9,450,823
California	19	19,882,487
Colorado	16	12,698,825
Idaho	15	18,315,806
Kansas	1	97,290
Montana	20	17,344,883
Nebraska	3	556,072
Nevada	4	766,959
New Mexico	12	7,024,504
Oklahoma	1	60,800
Oregon	12	11,569,848
South Dakota	4	1,263,720
Utah	16	6,731,306
Washington	5	7,785,600
Wyoming	7	8,629,626
Total, U. S.	135*	122,178,541

*Deducting duplicates caused by same reservation listed under two States.

The detailed figures on which the above information is based are given in a circular just issued by the U. S. Department of Agriculture, Forest Service (Mr. Gifford Pinchot, Forester).

A REINFORCED CONCRETE RAILING has been built by the Long Island R. R. at the top of the retaining wall of its depressed freight yards in Brooklyn, N. Y. The railing serves as a protection to pedestrians, there being a street at a level with the top of this wall. It consists of a succession of panels, each 5 ft. long, 4½ ft. high, and 3 ins. thick, except on the top edge where the concrete is rounded to form a molding or hand rail. The panels are reinforced with ¼-in. twisted steel bars spaced 9 ins. c. to c., both horizontally and vertically. The railing is held in a vertical position by transverse ribs on each panel. The panels are fastened to each other with four ⅛-in. dowel pins 6 ins. long inserted in holes in the transverse ribs. The concrete used was mixed in the proportion of 1:2:3, Portland cement and ¾-in. screened stone being employed. Each panel weighs approximately 1,000 lbs. The panels were placed in position by a portable trolley hoist.

GOVERNMENT AND MUNICIPAL OWNERSHIP OF telephones in Manitoba was approved recently by a vote of 14,072 to 10,302. Of the 114 municipalities, 54 voted in favor of the proposition by 60% and 7 others, or 61 in all, gave majorities for it; while 50 voted against it. It is reported that Mr. Francis Dagger, of Winnipeg, will represent the government in the building of long distance lines.

PERSONALS.

Mr. H. A. Boomer, Assistant General Superintendent of the Lake Erie & Western R. R., has been promoted to General Superintendent.

Mr. W. H. Jones, formerly Trainmaster of the Oregon Short Line R. R., has been appointed Assistant Superintendent of the Idaho Division.

Mr. L. D. Ricketts, Consulting Engineer to the Greene Consolidated Copper Co., has been appointed General Manager of the Greene-Cananea Co.

Mr. W. E. Condon has been appointed Chief Engineer of the Nevada Northern Ry., with headquarters at Ely, Nev. He succeeds Mr. D. H. Ashton, resigned.

Mr. Harry A. Lee, formerly Commissioner of Mines for the State of Colorado, has been appointed Consulting Engineer to the Unity Mines Corporation of Alta, Utah.

Mr. F. H. Miller, recently Superintendent of the Greenville Light & Power Co., Greenville, Ill., has become Erecting Engineer on electric cranes for the Case Mfg. Co.

Mr. George R. McLeod, Chief Clerk of the Transportation Department of the Grand Trunk Ry., has been promoted to Resident Engineer of the Middle Division of the road.

Mr. Frederick G. Myhtertz, a building inspector of Philadelphia, has been appointed Engineer of Construction for that city instead of New York, as stated in our last issue.

Mr. George W. Wallace has been engaged by the Cobalt Lake Mining Co. as Engineer, to superintend the partial draining of the lake, so as to gain a larger working area.

Mr. H. B. Stebbins has been appointed Chief Engineer of the Stover Mfg. Co., of Freeport, Ill. He was for four years Erecting Engineer for the Allis-Chalmers Co., of Milwaukee, Wis.

Mr. George W. Wildin, formerly Mechanical Superintendent of the Erie R. R., has been appointed Assistant Superintendent of Motive Power of the Lehigh Valley R. R. at South Bethlehem, Pa.

Mr. H. F. Schmidt, Senior Instructor of Mechanical Engineering at Michigan Agricultural College, has resigned and accepted the position of Assistant Editor of the "Electric Railway Review."

Mr. L. W. Wolfe, Superintendent of Water Supply on the Connellsville Division of the Baltimore & Ohio R. R., has been retired and placed on the pension list. He is succeeded by Mr. J. L. Fries.

Mr. Henry C. Allen, whose term of office as Special Deputy State Engineer of New York, in charge of the Barge Canal work, expired Jan. 1, has been appointed City Engineer of Syracuse, N. Y.

Mr. E. I. Bowen has been promoted from Trainmaster to Superintendent of the Allegheny and Bradford Divisions of the Erie R. R., to succeed Mr. J. C. Tucker, transferred to the Rochester Division.

Mr. W. B. Denham, General Manager of the Georgia, Florida & Alabama Ry., has resigned to assume full management of the Tampa Northern Ry., which is being built from Tampa, Fla., to Atlanta, Ga.

Mr. A. A. Miller has been appointed Division Engineer of the Philadelphia Division of the Baltimore & Ohio R. R., to succeed Mr. William Trapnall, promoted to Division Engineer of the Baltimore Division.

Mr. Roscoe H. Channing, Jr., has resigned as General Manager of the Utah Consolidated Mining Co., and has been appointed President and General Manager of the Cerro de Pasco Mining and Railroad companies.

Mr. S. M. Braden has been appointed General Superintendent of the Chicago & Northwestern R. R. lines west of the Mississippi River, to succeed Mr. C. E. Hughes. His headquarters are at Norfolk, Neb.

Mr. James Joyce, formerly Superintendent of the American Locomotive Automobile Co.'s plant at Providence, R. I., has been made Manager of the company, with headquarters at 1886 Broadway, New York City.

Mr. Robert S. Parsons, Engineer of Maintenance of Way for the Erie R. R., has been promoted to Assistant General Superintendent of the Ohio Division and the Chicago & Erie R. R., with offices at Cleveland, Ohio.

Mr. Norman Carmichael, Superintendent of the Arizona Copper Co.'s mines and concentrators at Morenci, Ariz., has been appointed Assistant General Manager of the company, and Second Vice-President of the Arizona & New Mexico Ry., with headquarters at Clifton, Ariz.

Mr. R. D. Tyler, Resident Engineer of the Western Division of the Franklin & Clearfield R. R., has been promoted to Division Engineer of the Western Division, with headquarters at Franklin, Pa. He succeeds Mr. F. T. Oakley, transferred to the Eastern Division, with office at Corsica, Pa.

Mr. H. P. Greenough, Superintendent of the 32d subdivision of the Chicago, Rock Island & Pacific Ry., has been appointed Superintendent of the lines north of Cedar Rapids, Iowa. Mr. Garrett A. Davis has been appointed Superintendent of the lines south of Cedar Rapids. Headquarters for both superintendents are at Cedar Rapids.

Mr. George W. Freeman has been appointed by transfer from the War Department, Engineer in the Reclamation Service, and assigned to duty on the Huntley project, Montana. Mr. Harrison P. Wires, Engineer, has been transferred from the Washington office of the Reclamation Service to duty with Mr. D. C. Henny, Portland, Ore.

Mr. Perry West, lately with the New York Edison Co., has been made head of the Power Plant Department of W. S. Barstow & Co., of New York City and Portland, Ore. He is a graduate of the State College of Kentucky in the mechanical engineering course, and has been connected with Joseph Williams & Co., Louisville, Ky., and Pattison Bros. Mr. Carl F. Schreiber, a graduate of the mechanical department of Columbia University, will be his assistant. Mr. Schreiber was formerly employed by the Brooklyn Rapid Transit Co., the New York Central & Hudson River R. R. and George F. Hanchett, Consulting Engineer. Another addition to the staff is Mr. Rulof Klein, formerly Designing and Constructing Engineer in the Gas Engine Department of the Wellman-Seaver-Morgan Co., Cleveland, Ohio. He is a graduate of the Delft Technical University, Holland, and a member of the Verein Deutsche Ingenieure and the Royal Institute of Dutch Engineers.

Obituary.

John P. Recktenwald, a retired contractor of Fremont, Ohio, died at his home in that city Jan 18, aged 77 years.

Nathaniel G. Foster, a retired architect of New York City, died at his home in Cranford, N. J., Jan. 17, of heart disease, aged 74 years.

Archibald R. Eldridge, M. Am. Soc. C. E., Assistant Bridge Engineer of the Chicago, Burlington & Quincy Ry., accidently shot and killed himself at Chicago, Ill., Jan. 17. He was engaged in cleaning a revolver at the time of the accident.

William Warren Garrett, Superintendent of the American Smelting & Receiving Co.'s plant at Aguascalientes, Mexico, died at San Antonio, Tex., Jan. 15, aged 29 years. He was a graduate of the Massachusetts Institute of Technology in the course of Mining Engineering, class 1902. For two years he was employed by the Boston & Montana Copper Co., and in 1904 became an instructor of mining engineering at Rolla College, Rolla, Mo. He resigned to become Superintendent of the American Smelting & Receiving Co. last September.

ENGINEERING SOCIETIES.

COMING MEETINGS.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 23-25. Annual Meeting at Peoria, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago, Ill.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 29. Annual Meeting at Montreal. Secy., Prof. C. H. McLeod, 877 Dorchester St., Montreal, Quebec.

THE NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 4-16. National Convention at St. Louis, Mo. Secy., Theo. A. Randall, Indianapolis, Ind.

NEW ENGLAND GAS ASSOCIATION.
Feb. 21. Annual Meeting at Boston, Mass. Secy., N. W. Gifford, East Boston, Mass.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 26. Annual Meeting at Toronto. Secy., Killaly Gamble, 405 Temple Bldg., Toronto, Ont.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
Mar. 19-21. Annual Meeting at Chicago, Ill. Secy., L. C. Fritch, 1562 Monadnock Block, Chicago, Ill.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.—The annual convention of the society was held at Seattle, Wash., Jan. 4-5. Following the President's annual address, which dealt largely with the subject of proper compensation for engineering work, an informal discussion on reinforced concrete was conducted by Mr. Frank P. Allen, Commissioner of Works for the Alaska-Yukon-Pacific Exposition. The papers read at the convention were as follows: "Producer Gas Power Plants," Mr. C. B. La Mont, President and Manager of the Pacific Engineering Co.; "Truth Concerning Steam Turbines," Prof. E. O. Eastwood, Professor of Mechanical Engineering, University of Washington; "Economical Location," Mr. T. A. Noble, Consulting Engineer, North Yakima, Wash. The convention closed Saturday evening with a banquet at Hotel Lincoln. The officers elected for the ensuing year follow: President, Mr. J. H. Fuller; First Vice-President, Mr. J. C. Jeffery; Second Vice-President, Mr. J. J. Cryderman. Third Vice-President, Mr. C. H. Rollins; Treasurer, Mr. Wendell N. Chase; Secretary, Mr. Arthur H. Dimock; Librarian, Mr. A. B. Coe; Directors, Messrs. Milnor Roberts, J. M. Clapp, J. L. McPherson, H. W. Scott, Geo. M. Gerhard, T. A. Noble, J. A. Thomson and W. R. Prowell.

IOWA ENGINEERING SOCIETY.—The nineteenth annual meeting of the society was held at Ottumwa, Iowa, Jan. 9-10. The opening session, Wednesday morning, was devoted to the address of welcome by Mr. M. C. Golmore, City Attorney of Ottumwa, and the President's annual address. The afternoon was spent in an inspection tour, the pumping station of the Public Water Co., the pork packing establishment of J. C. Morrell Packing Co. and the power station of the Ottumwa Railway & Light Co., being visited. At the evening session the following papers and reports were given: Bitulithic Pavement," Mr. C. S. Magowan; "Key West Extension of the Florida & East Coast Ry.," Mr. A. C. Irwin, and the reports of committees on reinforced concrete, electric railways, and railroad engineering. Thursday morning Mr. G. D. Dobson's paper on "Improvement of the Des Moines and Raccoon Rivers," and Mr. S. N. William's paper on "Improvement of the Mississippi River at Keokuk, Iowa," were read, as were also the reports of the committees on drainage, and roads and pavements. This session was followed by a business meeting when the following officers were elected: President, Mr. J. G. Ratcliffe, Waukon, Iowa.; Vice-President, Mr. A. J. Cox, Iowa City, Iowa; Secretary and Treasurer, Mr. A. H. Ford, Iowa City, Iowa; Directors, Messrs. C. R. Allen and W. H. Jackson.

THE ONTARIO ASSOCIATION OF ARCHITECTS.—The association opened its convention at the Ottawa Public Library Tuesday, Jan. 15, with a large number of architects from the various parts of Canada in attendance. The chief feature of the morning's program was a visit to the Geological Museum, where Director A. P. Low gave an exhibition of building stone. Later the visitors visited the site of the new Geological Museum.

Mr. Edmund Burke, of Toronto, delivered the president's address in the afternoon, and was followed by Mr. Stephen O'Brien, who discussed the Improvement Commission's work in Ottawa.

The conditions of competition for the plans of the new Parliament Building at Ottawa were fully discussed by the convention, and several changes suggested. The prizes offered are: first, $8,000; second, $4,000; third, $2,000; fourth, $1,000. It has decided to send a deputation to the Government, composed of the Montreal Architects, Messrs. Hutchinson and Perrault, and the Ontario Council, in an endeavor to secure the desired amendments.

The treasurer reported a surplus of $681 in the treasury, the largest amount on record. A report was presented from the Ottawa Chapter by Mr. Alexander, showing a membership of nine.

In the evening an enjoyable banquet was held at the Laurentian Club, at which some discussion took place relative to preserving the beauty of cities.

At the final session of the convention, Wednesday evening, the most important problem before the Ontario building experts—that of registration of architects—was discussed. The qualified architects object to mere artists with the pencil or men incapable of judging what is safe in structures being allowed to direct building operations. The committee appointed to present to the Government the recommendations of the association favoring changes in the conditions governing the competition for the plans of the new government buildings, reported that Hon. Sydney Fisher, Acting Minister of Public Works, gave assurance that the time for completing plans would be extended two months, and that the successful tenderer will be retained to carry out the work.

Mr. E. L. Horwood, of Ottawa, was elected to the 1907 council, the other two new members being Messrs. H. B. Moore and O. W. Gowanlock, both of Toronto. Mr. Edmund Burke, Toronto, was reelected President; Mr. W. A. Langton, Toronto, Vice-President; Mr. J. H. Watts, Ottawa, Second Vice-President; Mr. H. B. Gordon, Toronto, Treasurer; Mr. W. R. Gregg, Registrar.